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LESSONS FROM THE CENSUS.

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I.

WITH the statement of the total population of the country, and of each State distributed as to counties, cities, and towns, the popular interest in the Federal census begins to wane, and, as the results relative to the features other than merely of enumeration are obtained, the scientific interest increases. This interest is entertained by all classes of students: the economist desires immediate results as to production, wealth, debt, taxation, etc.; the social scientist is looking for statements relative to color and race, conjugal condition, the death-rate and health of the people, and facts covering various other relations; and the statesman and politician are anxious to secure comparisons of the growth of population, the changes incident to new productive enterprises, the concentration of wealth, and all the other expansive elements which concern the great discussions in which they are engaged. Under the new census, the eleventh, the interest of other bodies is brought into activity. The question as to whether the homes and farms of the country are owned by the occupants, and the extent to which they are mortgaged, as well as the psychological reasons for incurring mortgage indebtedness, serves to interest, and in a most lively way, the student who is sociologically inclined. The enumeration of the surviving soldiers and the widows of deceased soldiers of the war of the rebellion brings into play not only the interest of the veterans themselves but of the legislators of the country, and, in addition, the sentiment of the whole community. All these various features of our Federal census excite the interest of the people on a broader scale and in more thoroughly scientific directions than would the enumera-

tion of the people alone. Crystallized statements, and a somewhat popular analysis of the results of the census as they come out, must be of more or less value, and from them many lessons may be drawn. A series of articles, therefore, comprehending comparisons and analyses, and bringing out the salient points in all the vast quantity of material digested by the Census Office, can not fail to interest various elements of the population. It seems wise, however, before entering upon a discussion of the statistical features and of the scientific results of the census and the lessons to be drawn therefrom, that these first two chapters should be devoted to the system under which all these various results are obtained.

The United States census finds its organic authorization in the Federal Constitution, in accordance with Article I, section 2, as follows:

"Representatives and direct taxes shall be apportioned among the several States which may be included within this Union, according to their respective numbers, which shall be determined by adding to the whole number of free persons, including those bound to service for a term of years, and excluding Indians not taxed, three fifths of all other persons. The actual enumeration shall be made within three years after the first meeting of the Congress of the United States, and within every subsequent term of ten years, in such manner as they shall by law direct."

The only other reference in the Constitution to a census is in section 9 of Article I, wherein it is provided that "no capitation or other direct tax shall be laid, unless in proportion to the census or enumeration hereinbefore directed to be taken." This organic provision for a periodical census was the first of its kind in any country. It was the result of a good deal of discussion by the framers of the Constitution, and grew out of the difficulties which they experienced in apportioning representatives and taxation. There were wide differences of opinion in the Constitutional Convention; but after much deliberation the majority settled upon the form of language just quoted, and it became a part of the organic law of the land. There had been, prior to the adoption of the Constitution in 1789, various colonial and local censuses, and foreign countries had made enumerations at intervals of time; so that the framers of the Federal Constitution were not particularly unfamiliar with the benefits of census-taking; but the credit of the first regularly organized periodical census is due to the United States, and this country has had, commencing with 1790, regular enumerations of population, and since and including 1850 what might be denominated national censuses, comprehending various features other than the mere enumeration of the inhabitants of the country.

The general direction of the census was placed in the hands of the Secretary of State, where it remained until the passage of the census law of May 23, 1850, when all the functions of census-taking were put in charge of the newly created Department of the Interior, and all census laws since and including that have been administered under the direction of the Secretary of the Interior. The first schedule, that for 1790, was a very simple affair, and was as follows:

Schedule of the Whole Number of Persons within the Division allotted to A. B.

(1790.)

Names of heads of families.	Free white males of 16 years and upward, including heads of families.	Free white males under 16 years.	Free white females, including heads of families.	All other free persons.	Slaves.

In 1800 the scope of the population schedule was enlarged somewhat, and it was used in the following form:

Schedule of the Whole Number of Persons within the Division allotted to A. B.

(1800.)

Name of the county, parish, township, town, or city, where the family resides.	Name of head of family.	Free white males under 10 years of age.	Free white males of 10 and under 16.	Free white males of 16 and under 26, including heads of families.	Free white males of 26 and under 45, including heads of families.	Free white males of 45 and upward, including heads of families.	Free white females under 10 years of age.	Free white females of 10 years and under 16.	Free white females of 16 and under 26, including heads of families.	Free white females of 26 and under 45, including heads of families.	Free white females of 45 and upward, including heads of families.	All other free persons, except Indians, not taxed.	Slaves.

The foregoing schedule was used in 1810 without change, but the scope of the census, by act of May 1, 1810, was enlarged. This act required the several marshals, secretaries, and their assistants, "at the time for taking the census or enumeration aforesaid, to take, under the direction of the Secretary of the Treasury, and according to such instructions as he should give, an account of

the several manufacturing establishments and manufactories within their several districts, territories, and divisions"; but no schedule was incorporated into the law, the whole matter being left to the discretion of the Secretary of the Treasury as to construction. No very valuable results were obtained under this provision; yet the experiment was repeated in 1820, under the law of March 14th of that year, which made it the duty of the "several marshals and their assistants, at the time for taking the said census, to take, under the direction of the Secretary of State, and according to such instructions as he shall give, and such forms as he shall prescribe, an account of the several manufacturing establishments and their manufactures, within their several districts, territories, and divisions." These attempts to enlarge the census so as to include statistics of manufactures were so barren of valuable results that in taking the census of 1830 the attempt was wholly abandoned. The manufacturers' schedule was, however, introduced again in 1840; but still the effort was of little account, and it was not until the census taken under the broader law of 1850 that any valuable results were reached. So the census grew, from the simple enumeration of the people in 1790, under the very brief schedule which has been given, not only through various additions to the population schedule, but by the introduction of inquiries relating to production, until nearly all the material conditions surrounding the people, their industries, their wealth, their taxation, their carrying trade, fisheries, schools, health—nearly everything, in fact, that the social scientist wishes to know concerning the people and their conditions—are embodied in the census. With the changes in the scope of the census there have been changes in the methods of enumeration. Until 1880 the United States marshals for the several districts were authorized, under the first census law, approved May 1, 1790, to make the enumeration, the marshals having power to appoint as many assistants within their respective districts as should appear necessary. The enumeration was to commence on the first Monday in August, 1790, and it was provided by law that it should close within nine calendar months thereafter. The marshals were required to file the returns with the clerks of their respective district courts for careful preservation, and to forward the aggregate amount of each description of persons within their respective districts to the President of the United States. Each assistant marshal was required, previous to making his return to the marshal, to cause a correct copy of the schedule, signed by himself, to be set up at two of the most public places within his division, there to remain for public inspection. The use of United States marshals in taking the censuses was continued until the tenth census, that of 1880, although an effort was

made to provide other machinery for the ninth census, that of 1870. This effort was embodied in a bill which passed the House of Representatives, but which was defeated in the Senate; so the census of 1870 was taken in accordance with the law of 1850. The act for the tenth census, approved March 3, 1879, provided that enumerators, specially appointed for the purpose, should make the canvass, the body of enumerators working under supervisors appointed by the President. Under this law there were one hundred and fifty supervisors, under whom were employed about thirty thousand enumerators, and under the last-named law the scope of the census was greatly expanded, nothing like it ever having been carried out under any government. The enumerators were to make the canvass from house to house, from manufactory to manufactory, from farm to farm, sending their certified returns to their respective supervisors, who, after careful examination, transmitted the originals to the superintendent at Washington. By this method the central office was put in possession of the original data, avoiding thereby all the errors incident to transcription under previous methods. General Francis A. Walker was the superintendent, and he was also the superintendent of the ninth census, that of 1870. He carried through the census of 1880 on the broad basis laid down by him, and the results, in twenty-two folio volumes, secured for him the admiration of statisticians in every part of the world.

Now comes the eleventh census, the centennial of that of 1790. It is being conducted under a law which is practically the re-enactment of that providing for the tenth census. The law was approved March 1, 1889, and under it Robert P. Porter was appointed superintendent. The schedules are practically those of the tenth census, enlarged, amended, and improved as experience under the tenth census indicated the necessity.

The growth of the Federal census, while clearly illustrated by reference to the various laws, is perhaps more strikingly shown by a statement of the various publications which have resulted from the several censuses. General Garfield, chairman of the Committee on the Ninth Census, made in January, 1870, a very elaborate report covering census-taking in different countries in the world, and especially a history of the United States censuses; and from this report the exhibit relative to publications and expenses up to and including 1860 is taken. For 1870 and 1880 recourse has been had to original sources:

1790.—Return of the Whole Number of Persons within the Several Districts of the United States, etc. This first census publication was an octavo pamphlet of 52 pages, published in 1792. The entire cost of this census was $44,377.18.

1800.—Return of the Whole Number of Persons within the

Several Districts of the United States, etc. This was a folio of 78 pages, published in 1801. The cost of this census was $66,609.04.

1810.—The report of this census was in two folio volumes: I. Aggregate Amount of each Description of Persons within the United States, etc. This was an oblong folio of 90 pages, but it does not show the date of publication. II. A Series of Tables of the Several Branches of American Manufactures, exhibiting them in every County of the Union, so far as they are returned in the Reports of the Marshals and of the Secretaries of the Territories, and of their Respective Assistants, in the Autumn of the Year 1810; together with Returns of Certain Doubtful Goods, Productions of the Soil and Agricultural Stock, so far as they have been received. Quarto, 170 pages. Edited by Tench Coxe, and published May 30, 1813. The cost of the census of 1810 was $178,444.67.

1820.—I. Census for 1820, etc., a folio of 164 pages, published in 1821. II. Digest of Accounts of Manufacturing Establishments, etc., a folio of 100 pages, printed in 1823. Cost of the census, $208,525.99.

1830.—Fifth Census or Enumeration of the Inhabitants of the United States. This volume was a large folio of 163 pages, printed in 1832. This report was so wretchedly printed that Congress required by law a republication, which was made the same year, under the immediate direction of the Secretary of State. The erroneous and corrected editions are bound together. This republication enhanced the cost of this census to $378,543.13.

1840.—I. Compendium of the Enumeration of the Inhabitants and Statistics of the United States, a folio of 379 pages, printed in 1841. II. Sixth Census or Enumeration of the Inhabitants of the United States, a folio of 470 pages, 1841. III. Statistics of the United States, etc., a large, oblong folio of 410 pages, 1841. IV. Census of Pensioners for Revolutionary and Military Service, with their Names, Ages, and Places of Residence, etc. Quarto, 196 pages. The total cost of these censuses was $833,370.95.

1850.—I. The Seventh Census of the United States, quarto of 1022 pages, 1853. II. Statistical View of United States, octavo of 400 pages, 1854. III. Mortality Statistics of the Seventh Census, etc., octavo, pp. 304, 1855. IV. Digest of the Statistics of Manufactures, octavo, pp. 143, published in 1859 as Senate Executive Document, No. 39, second session Thirty-fifth Congress. Cost up to September 30, 1853, $1,318,027.53. There were three or four subsequent appropriations for this census, amounting to about $11,000.

1860.—I. Preliminary Report of the Eighth Census, 1860, octavo, 294 pages, 1862. II. Final Report, in four quarto volumes, as follows: Vol. I. Population, pp. 694. Published in 1864. Vol.

II. Agriculture, pp. 292. Published in 1864. Vol. III. Manufactures, pp. 746. Published in 1865. Vol. IV. Mortality and Miscellaneous Statistics, pp. 548. Published in 1866.

The total cost of the eighth census was, in round numbers, $2,000,000.

1870.—The results of the ninth census were embodied in three quarto volumes, as follows: Vol. I. Population and Social Statistics, pp. 875. Published in 1872. Vol. II. Vital Statistics, pp. 705. Published in 1872. Vol. III. Statistics of Wealth and Industry, pp. 849. Published in 1872.

The cost of the ninth census, including printing, was $3,696,227.37.

1880.—The results of the tenth census made an encyclopedic report of twenty-two quarto volumes and a compendium.

The cost of the tenth census, including printing, was $5,862,750.24.

The eleventh census, that for 1890, is being taken under the act approved March 1, 1889, and comprehends all the features of the tenth, with two great additions—an account of the mortgage indebtedness on homes and farms, and an enumeration of the surviving veterans of the war of the rebellion. The machinery of the census is practically the same as that organized for the tenth. The forces employed, however, are vastly greater, numerically considered. The number of supervisors was increased to 175. The whole body of enumerators constituted an army of 46,546. The largest number of office employés, not including special agents, was on May 9, 1891, 3,142; and the number of special agents, including special agents on manufactures in cities, was 1,938, or a total force June 1, 1891, exclusive of enumerators, of 5,080. The appropriations, up to July 1, 1891, have been $7,400,000. To complete the work there will be required another and quite large appropriation. The organization of the Census Office, January 1, 1891, comprehended twenty-five specific divisions, each division being under the charge of a chief of division or an expert special agent. These twenty-five divisions are charged with the business features of the Census Office, and the collection and tabulation of the facts relating to the subjects indicated in the following list:

First Division.—Appointments.
Second Division.—Disbursements and Accounts.
Third Division.—Geography.
Fourth Division.—Population.
Fifth Division.—Vital Statistics.
Sixth Division.—Church Statistics.
Seventh Division.—Educational Statistics.
Eighth Division.—Pauperism and Crime.

Ninth Division.—Wealth, Debt, and Taxation.
Tenth Division.—National and State Finances.
Eleventh Division.—Farms, Homes, and Mortgages.
Twelfth Division.—Agriculture.
Thirteenth Division.—Manufactures.
Fourteenth Division.—Mines and Mining.
Fifteenth Division.—Fish and Fisheries.
Sixteenth Division.—Transportation.
Seventeenth Division.—Insurance.
Eighteenth Division.—Printing and Stationery.
Nineteenth Division.—Statistics of Special Classes.
Twentieth Division.—Supervisors' Correspondence.
Twenty-first Division.—Alaska.
Twenty-second Division.—Statistics of Indians.
Twenty-third Division.—Social Statistics of Cities.
Twenty-fourth Division.—Accounts, Farms, Homes, and Mortgages.
Twenty-fifth Division.—Revision and Results.

The progress of this vast work is probably at the present writing in as forward a state as could be expected, when the volume of data called for, as indicated, is considered. The results—showing aggregate population by States, counties, and minor civil divisions, and by sex; condensed classification by ages, showing the school, militia, and voting ages, by native and foreign white persons and colored persons—will be put into compendium form and published, without much doubt, before the close of the present calendar year. The classification regarding families and dwellings, the volume of final reports for population, showing the results in detail, by ages, conjugal condition, place of birth, and all the varied distinctions of population, must not be expected until some time in 1892, possibly by the early summer. All this work is enough for the Census Office to handle at one time; but when there is added to it the multitudinous divisions shown in the foregoing list, it is not to be wondered at that progress is slow, that the country criticises, and that increased appropriations are called for. No superintendent, burdened with the present system, can possibly satisfy the country, Congress, or himself. And so the first lesson to be drawn from the census relates to the system rather than to the results under it, and to what changes are needed that the system may be improved.

A RECENT find of mummies of dogs in Egypt has prompted M. Maspero to suggest that these objects may furnish opportunities for studying the characteristics of the most ancient of the domesticated species. Some efforts have been made to determine these from the wall-paintings, but the data they afford are very uncertain.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

VIII. THE MANUFACTURE OF STEEL.

By WILLIAM F. DURFEE, Engineer.

IT is now two hundred and thirty-six years since the first American steel maker of which we have any record, Mr. John Tucker, of Southold, Long Island, informed the General Court of Connecticut of his "abilitie and intendment to make steele there or in some other plantation in this jurisdiction, if he may have some things granted." The court (says Bishop) acquiesced in a grant of privileges, and, in the following May, Tucker obtained from the Assembly a declaration "that if he doe laye out his estate in such a manner about this publique worke, and that God shall cross him therein so that he be impoverished thereby, they are willing that that small remaining part shall be free from rates for ten years."* Possibly Tucker thought that the "protection" guaranteed by the colony was not sufficient, as we have no evidence that he ever availed himself of it, or was ever "impoverished thereby."

In 1728 Samuel Higley, of Simsbury, and Joseph Dewey, of Hebron, in Hartford County, Connecticut, represented to the Legislature that the said Higley had, "with great pains and cost, found out and obtained a curious art by which to convert, change, or transmute common iron into good steel sufficient for any use, and was the first that ever performed such an operation in America."† Swank gives on the authority of Mr. Charles J. Hoadly, Librarian of the Connecticut State Library, a certificate, signed by Timothy Phelps and John Drake, blacksmiths, which states that, in June, 1725, Mr. Higley obtained from the subscribers several pieces of iron, so shaped that they could be known again, and that a few days later "he brought the same pieces which we let him have, and we proved them and found them good steel, which was the first steel that ever was made in this country that we ever saw or heard of."

A patent was granted Higley and Dewey for ten years, pro-

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* New Haven Colonial Records, vol. ii, p. 173.

† Bishop tells us that "the first patent granted in England for the manufacture of steel was to Richard Lord Dacre, Thomas Letsome, and Nicholas Page, on 8th April, 1626, for apparatus for making steel, according to the inventure of Letsome." In 1655 "there was but little steel made in England, and that very imperfectly and all of foreign Iron." Forty years after (in 1695) English writers speak of steeling articles by "boiling them in raw metal," and steel was made by a similar process, and was "made by cementation by John Heydon, at Bromley, in 1697."

vided "the petitioners improve the art to any good and reasonable perfection within two years from the date of this act." They do not appear to have done this, or to have continued the business of making steel.

In 1740 the Connecticut Legislature granted to Messrs. Fitch, Walker & Wyllys "the sole privilege of making steel for the term of fifteen years upon this condition, that they should in the space of two years make half a ton of steel"; this condition not having been complied with, the privilege was extended to 1744, before which time Aaron Eliot and Ichabod Miller certified that more than half a ton of steel had been made at the furnace in Symsbury.

Some time before 1750 a steel-furnace was in operation at Killingworth, in Middlesex County, Connecticut. This furnace (says Swank) was owned by Aaron Eliot, and in it he succeeded, in 1761, in converting into good steel a bar of iron, made in a blomary fire from magnetic sand, by his father, the Rev. Jared Eliot.

Mr. Swank quotes from Mr. Hoadly a petition presented to the Legislature of Connecticut in May, 1772, by Aaron Eliot, in which the petitioner recites that his capital "has not been large enough to supply himself with a sufficient stock to carry on his business, & has, therefore, hitherto been obliged to procure his stock of iron from New York on cred^{t}, and pay for the same in his steel, when made, at the moderate price of £56 per ton [$186.66⅔, the £ being equal to $3.33⅓], from whence it has been again purchased in this Colony at the price of £75 and £80 per ton; and, for several years past, almost the whole supply of steel in this Colony has been from New York, of the manufacture of your memorialist, at the afores^{d} enormous advance." He accordingly begs for a loan of £500 from the public treasury for three years without interest; this, he says, would "save large sums of money within this Colony, which is annually paid to New York for the steel manufactured in this Colony."

Eliot's prayer was granted, and in 1775 the loan was renewed for two years longer. It appears from returns made by the Colonial Governors in 1750, in conformity with the Act of Parliament, that Massachusetts, Connecticut, and New Jersey had each one steel-furnace, and Pennsylvania two; both of these were in Philadelphia, owned by William Branson and Stephen Paschal, respectively. Branson stated in regard to his steel that "the sort he made, which was blistered steel, ten tons would be ten years in selling." Paschal's furnace was built in the year 1747, on a lot at the northwest corner of Eighth and Walnut Streets; this furnace in 1787 was owned by Nancarrow & Matlock, when it was visited in that year by General Washington, and said to have

been "the largest and best in America." Whitehead Humphreys, who in 1770 was the owner of a steel-furnace on Seventh Street, Philadelphia, and made steel for the Continental army, was granted in 1786, by the Legislature of Pennsylvania, a loan of £300 for five years, to aid him in making steel from bar iron "as good as in England."

In 1777 Rhode Island "gave £60 per gross ton for good German steel made within the State."*

The Legislature of Massachusetts granted in 1778, to the Rev. Daniel Little, "£450, to aid in erecting at Wells [in the District of Maine] a building 35 × 25 feet, to be used in manufacturing steel." †

In 1787 the manufacture of steel was commenced in the town of Easton, Massachusetts, by Eliphalet Leonard, and we are told by Bishop that "the article was made in considerable amount, and cheaper than imported steel." About 1797 steel was made at Canton, in the same State, "from crude iron, by the German process." Peter Townsend, the proprietor of the Sterling Iron Works, in New York, made in 1776 the first steel produced in that province, and his son, Peter Townsend, Jr., is said to have made, at the same works, in 1810, steel "of as good quality for the manufacture of edged tools as that made from Dannemora iron."

Alexander Hamilton, in a report dated December 5, 1791, says, "Steel is a branch which has already made considerable progress, and it is ascertained that some new enterprises on a more extensive scale have been lately set on foot." In the same year Tench Coxe, in replying to Lord Sheffield's Observations on the Commerce of the United States stated that "about one half of the steel consumed in the United States is home-made, and new furnaces are building at this moment."

Swank states that "in 1805 there were two steel-furnaces in Pennsylvania which produced annually one hundred and fifty tons of steel. One of these was in Philadelphia County. In 1810 there was produced in the whole country nine hundred and seventeen tons of steel, of which Pennsylvania produced five hundred and thirty-one tons in five furnaces. . . . The remainder was produced in Massachusetts, Rhode Island, New Jersey, Virginia, and South Carolina; each State having one furnace. In 1813 there was a steel-furnace at Pittsburgh, owned by Tuper & McKowan, which was the first in that city."

All the steel manufactured in America prior to the year 1810 was produced either by what was called the "German method," which was conducted in a "hearth" similar to that used for a "blomary fire," or by the "cementation process." The "Ger-

* Economic and Social History of New England, 1620–1789, by W. B. Weeden. † Ibid.

man steel" was made directly from the ore or a suitable quality of "pig iron" was used. The operation, when ore was employed, consisted in removing the oxygen, and then by appropriate manipulation, together with a regulation of the blast and heat, the iron was combined with carbon derived from the fuel to such a degree as to convert the metal into a mass of crude steel; this was carefully drawn under a light, quick-working hammer into bars about an inch square; six or eight pieces of these bars were made into a "pile," welded together, and drawn into smaller bars. This process, called "refining," was repeated a number of times, and the quality of the resulting steel was designated by the terms "single," "double," or "triple refined," according to the number of weldings and hammerings. When "pig iron" was used, the operation consisted in so manipulating the metal and regulating blast and heat that a portion of the carbon in the "pig" remained in the resulting "bloom" of crude steel, which was subjected to the same "refining" as has just been described.

All the early attempts to make steel in America were in the "German manner"; but it was soon discovered that the ores and pig irons available were not of a proper quality, and attention was early directed toward the "cementation process," the details of which were fully described by Réaumur in 1722.*

The operation of making "cemented" or "blister" steel consisted essentially in packing bars of wrought iron in charcoal-dust in long boxes or "pots" made of sandstone or fire-brick. These "pots" were covered as nearly air-tight as possible and subjected to a high degree of heat (not, however, sufficient to melt the bars of iron), which was regulated as to temperature and duration according to the contemplated use to be made of the steel. As a rule, the higher the temperature and the longer time it was kept up, the greater the degree of carburization of the bars in the "pots" and the harder the resulting steel. When the iron is packed in the charcoal, one or more bars are allowed to project through openings in one end of the "pots"; these bars are removed at proper intervals of time, and from their appearance when cold the progress of the operation was judged. When the process of "cementation" was finished, the furnace was allowed to cool, and, as soon as men could work therein, the metal was removed from the "pots," and it was found that it had undergone a great change: instead of having a smooth surface, it was covered with a large number of "blisters" of varying size and thickness (hence the name "blister steel"), and, although when put into the "pot" the metal was very fibrous and tough, it was found

* L'art de convertir le fer forgé en Acier, et l'art d'adoucir le fer fondu, ou de faire des Ouvrages de fer fondu aussi finir que de fer forgé. Par Monsieur de Réaumur, de l'Académie Royale des Sciences. A Paris, 1722.

on removal to be very crystalline and brittle. These changes of structure and fracture were due to the absorption of carbon from the charcoal dust in which the bars had been packed.

Fig. 50 is a cross-section of a "cementation" or "blister-steel" "converting furnace," in which the various parts are so plainly designated that additional description is unnecessary. The degree of carburization, and consequently the hardness of the steel produced in such a furnace, necessarily varied, and for the convenience of manufacture and trade the product was assorted into six grades or "heats."*

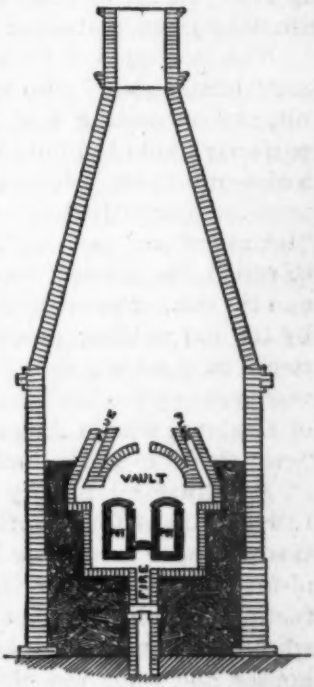

FIG. 50.—CROSS-SECTION OF A CONVERTING FURNACE FOR BLISTER STEEL.

When steel was wanted of closer grain, firmer texture, and more reliable character, a certain number of bars of this "blister steel" were made into a bundle or "fagot" and welded together, and the resulting bar was called "single shear" steel; and if a still higher quality was required, bars of "single shear" were welded and drawn into bars called "double shear steel."†

Previous to the year 1812 we have no record of there having been any steel produced in America by other than the processes already described, but in that year John Parkins and his son, Englishmen, "are said to have made an unsuccessful attempt to make *cast steel* in New York City,"‡ and the same authority tells us that they were employed, in 1818, at Valley Forge, Pa., to make *cast steel* for a saw manufactory.

In 1831 John R. Coates, of Philadelphia, stated that there were then in the United States fourteen blister-steel furnaces, which had "a capacity sufficient to supply more than sixteen hundred tons of

* No. 1, spring heat, about ¼ per cent carbon; No. 2, country heat, about ⅜ per cent; No. 3, single shear heat, about ½ per cent; No. 4, double shear heat, about 1 per cent; No. 5, steel through heat, about 1¼ per cent; No. 6, melting heat, about 1½ per cent.

† Percy and other writers on the manufacture of steel have stated that the term "shear steel" originated from the fact that such steel was used in making the blades of shears; but, as steel of the same quality was employed for multitudes of other implements, and as "blister steel" was made in Germany before it was in England, it appears to the writer more probable that the result of refining and improving its quality by successive weldings received the German appellation of *Sicker-stahl* (sure, or trusty steel), which was mistranslated into the English term "shear steel."—W. F. D.

‡ Swank—Iron in All Ages.

steel annually, an amount equal to the whole importation of steel of every kind. . . . The only steel now [1831] imported from Great Britain is of a different and better quality than that just mentioned." *Cast steel* was not then made in the United States. This variety of steel was invented in England, by Benjamin Huntsman, in 1740. Mr. Huntsman was a watch-maker, and also made clocks, roasting-jacks, and other mechanical contrivances.

The invention of Huntsman consisted substantially in breaking "blister steel" into small fragments, placing these in a crucible, and subjecting that to sufficient heat to render its contents perfectly fluid; the fluid steel was then poured (or "teemed") into a cast-iron mold. Melting the "blister steel" removed all its solid infusible impurities, and when the ingot which resulted from the "teeming" (or "casting," hence the term cast steel) was hammered or rolled, the product was found to be much more homogeneous, and the temper more uniform, than was ever the case in steel made by the old welding process. The first attempt to produce "cast steel" in America that is fairly entitled to be called successful was made by the brothers William and John Hill Garrard, natives of England, who in August, 1832, commenced the manufacture of "cast steel" in works located on the Miami Canal, at Cincinnati.

Metallurgical history is indebted to James M. Swank* for a full account of these works, including a statement of Dr. William Garrard, who was living in 1884. As to the commercial success of his manufacture, Dr. Garrard says: "I sold my steel and manufactured articles principally to manufacturers. There were some wholesale houses that bought of me, but they were importing houses, and when the Sheffield manufacturers found that I was making as good steel and manufactured saws and files as good as they did, they gave our merchants such an extended time of credit that they bought as little as possible from us." The Cincinnati Steel Works, as this establishment was called, continued in operation until 1844, although in the last seven years of their existence the principal product was blister steel. That the cast steel made in these works was of excellent quality there is abundant proof.

It is impossible within the space available to give in detail an account of the many attempts that were made in various parts of the country, but chiefly in Pennsylvania, between the years 1830 and 1860, to manufacture steel of the best quality. The reasons for the almost uniform failure can now be very easily assigned; there was a universal ignorance of chemistry and a consequent contempt for its teachings, and the experimenters had not sufficient knowledge of practical metallurgy to utilize their occasional

* In Iron in all Ages.

successes, or to draw intelligent inferences from their much more common failures. One somewhat prominent firm was so persistent in their ignorant faith that a certain iron was the best in America that, when they discovered that good steel could not be made therefrom, they abandoned an enterprise in which many thousands of dollars had been expended, because they firmly believed that they had demonstrated that it was impossible to make cast steel from American iron.

Swank tells us that in 1850 there were thirteen steel works in Pennsylvania which produced in that year 6,078 tons, of which but 44 tons were "cast steel." According to the same authority, the "Adirondack Iron and Steel Company, whose works were at Jersey City, N. J.," succeeded in February, 1849, in making "cast steel" in black-lead crucibles by melting "blister steel," made from iron that had been puddled with wood as the fuel. "Of the excellent quality of the "cast steel" manufactured at this time at these works there is abundant evidence in the testimony of Government experts and of many consumers. . . . It was used for chisels, turning and engravers' tools, drills, hammers, shears, razors, carpenters' tools, etc. Its manufacture was continued with encouraging results until 1853, when the business was abandoned by the company. It had not proved to be profitable, partly because of the prejudice existing against American 'cast steel,' and in some degree to the irregularity of the temper of the steel produced." The firm of Hussey, Wells & Co., of Pittsburg, began the erection of works in 1859, and in the following year they entered upon a successful business in the making of crucible cast steel of the best quality from American iron. In 1862 the firm of Park Brothers & Co., also of Pittsburg, achieved success with the same material. These were the first firms in America who were commercially as well as mechanically successful in the manufacture of "cast steel." Their works are still in operation and their products are well and favorably known.

There are various methods of making "crucible cast steel" besides that already mentioned as the discovery of Huntsman; one of these, which is in very common use, consists of melting in a plumbago crucible a certain weight of wrought iron cut into small pieces together with a sufficient amount of charcoal powder to properly carburize it during the process of fusion. Another method is to melt together proper proportions of "pig" and "wrought" iron. In all of the modern processes of making "cast steel" manganese enters in some form, its chief use being to effect the removal of any oxygen that may be present in the metal used.

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We shall not attempt a description of the multitudes of "mixtures," "fluxes," and "physics," each intended to work wondrous

beneficent changes in material positively bad, and to so purify and purge it that it would inevitably produce steel phenomenally good, that wearied the minds, vexed the souls, and too often imparted a lurid hue and sulphurous flavor to the language of the early makers of cast steel. These nostrums represented every school of "medicine"; one prescribed heavy doses of certain "salts," another was loud in the praises of minute pellets of his most potential preparation; one of the advocates of the botanical treatment extolled the efficacy of a raw potato to "agitate the metal" * and cause it to throw off all its superfluities, while the "eclectics" roamed through all the fields of "physic" and claimed to appropriate all the virtues and ignore the vices of the other practitioners.

The original method of melting cast steel consisted in placing a single "pot" with its contents in a square vertical furnace, or "hole," whose top was level with the floor of the "casting house"; the furnace was then filled with either coke or anthracite coal, care being taken that the fuel was distributed equally on all sides of the "pot," which was provided with a "lid" to protect its contents from contamination by the entrance of coal or other matter.

The fire was then urged by the powerful draught of a chimney, or frequently by a "blower." Many of the later "melting holes," in which solid fuel was used, were made large enough to contain two, and some of them four "pots."

All the cast steel made in America prior to the year 1868 was melted by solid fuel in "holes" such as have been described; but in November, 1867, Messrs. Anderson and Woods, of Pittsburg, procured a license from the American owners of the Siemens patents for "regenerative gas furnaces," and under this license a "twenty-four pot" melting furnace was erected under the supervision of William Durfee,† in their works at Pittsburg, Pa., in the spring of 1868, according to plans prepared by J. Thorpe Potts, C. E., who represented Dr. Siemens in America. This was the pioneer furnace in the United States using gaseous fuel for melting cast steel, and its success led to their rapid introduction in other works, so that to-day there are not many of the old-fashioned "holes" using solid fuel to be found.

In Fig. 51 we have a vertical cross section of a "Siemens regenerative gas furnace" for melting cast steel. Fig. 52 is a top view of the furnace, showing two of the "melting holes" covered and six "pots" in place in the open hole; the top of the furnace

* Another "crank" claimed to have discovered a liquid in which if "pigs" of iron were "soaked" a certain time they would be cleansed of all their impurities, and could then be converted into steel by simple fusion. This might have been with propriety called the "hydropathic process."

† Father of the writer.

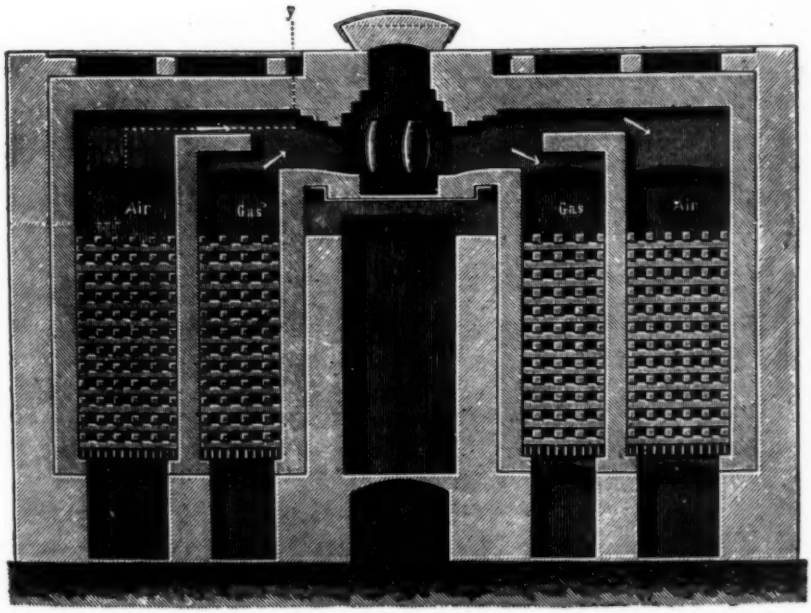

FIG. 51.—VERTICAL CROSS-SECTION OF A SIEMENS FURNACE FOR MELTING STEEL IN POTS.

on the left having been removed to show the flues. The distinguishing peculiarity of the "Siemens furnace" is the method of utilizing the escaping heated products of combustion for heating the incoming gas and air. This is accomplished by what are called the "regenerative chambers," which are situated to the right and left of, and at a lower level than, the "melting holes." As will be seen in Fig. 51, there are four of these chambers, the two smaller being for gas, and the two larger for air.

Air enters the flue at the lower part of the left-hand chamber, and, passing upward, it absorbs whatever heat may be in the reticulated mass of fire-brick with which the chamber is filled, and, on reaching its top, it turns to the right in the direction of the arrow, and, just previous to entering the "melting hole," it encounters and combines with the incoming gas, which also has been highly heated by contact with the bricks in the "gas chamber." The result is the ignition of the gas immediately at the entrance to the "melting hole"; intense combustion ensues, the ignited gas expanding and completely enveloping the "pots," and the highly heated products of this combustion leave the "melting hole" on the side opposite to that at which they entered, and on their way to the chimney they pass through each of the right-hand chambers of the furnace, and in their passage raise the bricks therein to a high temperature.

After the furnace has worked for a proper time in the way

described, the brick-work in the left-hand chambers will have become considerably cooled, and then the "melter" reverses certain valves (not shown in the figures), causing the currents of gas and air to be reversed—that is to say, the gas and air will now come in through the right-hand chambers and pass out through the left. In this way a very intense heat is maintained in the "melting hole," which can be regulated at pleasure by varying the amount and proportion of the gas and air used. The advan-

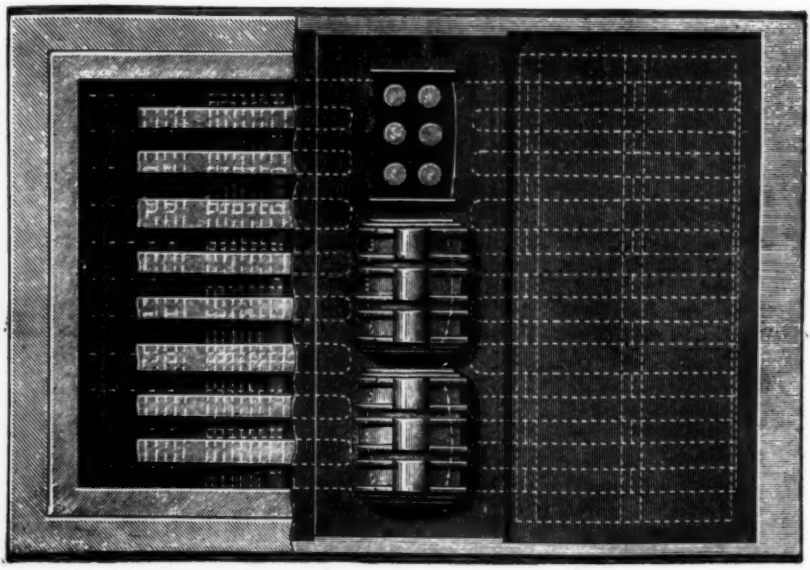

FIG. 52.—PLAN OF SIEMENS POT FURNACE.

tages of this furnace are sufficiently numerous and important to make its employment compulsory in all well-administered establishments.

In whatever kind of a furnace the steel is fused, as soon as the metal in the "pots" is thoroughly melted they are removed therefrom by a pair of tongs similar to those shown on the "pot" at the right hand of Fig. 53, and the "teemer" then grasps the "pot" with another pair of tongs and "teems" (pours) the fluid steel into an ingot mold of cast iron, care being taken that the stream of metal passes down the center of the mold without coming in contact with its sides.

The heat of the whole operation of "pulling out" the "pots" and "teeming" the steel (which last is well represented in Fig. 53) is so great that the workmen envelop their limbs in thoroughly soaked woolen cloths (technically called "rags"), which require wetting repeatedly during the casting of a "heat" of steel.

When the manufacture of cast steel was first undertaken in

England, the "ingots" of steel were drawn into bars of various sizes and shapes, under quick-working "tilt-hammers," and this operation was called "tilting the steel"; the "tilter" sat in a suspended seat, and moved his body to and from the anvil by his feet, while his eyes were fully occupied in watching the size and form of the bar, and his hands in turning it upon the anvil. The English machinery and practice were copied in this country, in the

FIG. 53.—"TEEMING" AN INGOT OF STEEL.

early steel works, and a plant of steel "tilting-hammers" is shown in Fig. 54. No small part of the expense of maintaining such a plant was the cost of timber for the wooden "helves" of the hammers, which, notwithstanding the heavy bands of iron encompassing them, required frequent renewal, owing to the shattering effect of the heavy and constantly repeated blows to which they were subjected. At the present time all "cast steel" is drawn under steam hammers, whose construction is a modified form of that invented by Nasmyth, already described.

The first step toward the production of steel in such large

masses as were required for cannon, armor-plate, the shafts of ocean steamers, and parts of steam-engines of the largest class, was the making of steel by a modification of the puddling process, whence the new product was called "puddled steel." The operation consisted in using a superior quality of charcoal pig iron, and in so manipulating it that the carbon was only partly removed; and the resulting product was a weldable and forgeable metal, possessing many of the qualities of the softer varieties of steel. The art of puddling steel is of German origin. The first efforts to practice it are said to have been made at Frantschach, by Schlegel and Müller, in 1835. This and several other attempts failed, and "it was not until 1850 that good puddled steel was produced in the iron-works of Messrs. Lehrkind, Fakenroth & Co., at Haspe, by following the suggestions of the chemist Lahaye."*

The process was introduced into England in 1850 by Ewald

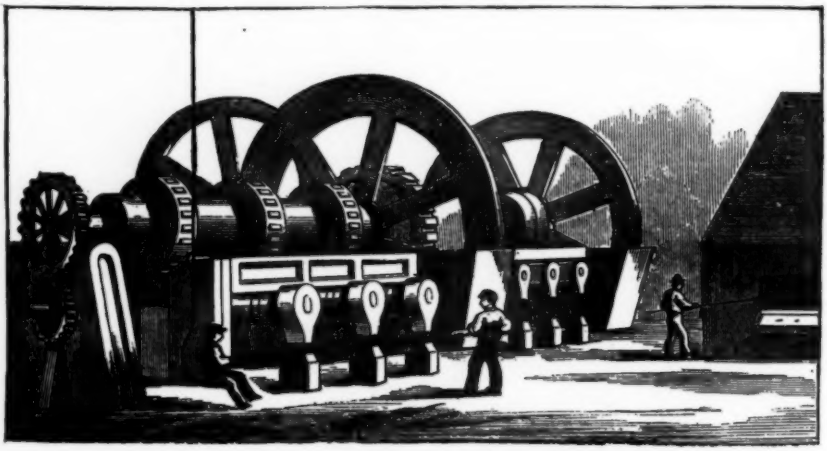

FIG. 54.—OLD STYLE OF STEEL "TILTING-HAMMERS."

Reipe, and hence became known there as the "Reipe process"; it was patented in 1859 in the United States by Anton Lohage, and was operated for a time by Messrs. Corning & Winslow, of Troy, N. Y., and by Messrs. James, Horner & Co., at Pompton, N. J. In 1870 there were eleven hundred and eighty-five tons of "puddled steel" made in this country, valued at $218,500; but before the year 1880 the process appears to have become obsolete in America. By their neglect of this process the owners of American iron and steel works threw away what would have been to many of them a source of great profit during the twenty years preceding the introduction of the "Bessemer" and "open-hearth" processes of manufacturing steel. In Europe, however, during the past forty years, a very large amount of steel has been made in this way,

* Practical Treatise on Metallurgy, by Crookes and Röhrig.

much of it for remelting in pots, and a great deal being used for forgings. In the "Centennial Exhibition of 1876" there was shown in the Swedish department by the "Motala Iron and Steel Works" a number of welded coils of "puddled steel" intended for "gun-hoops" and several finished "hoops."

The introduction of the "Bessemer process" into the United States preceded by a few years that of the "open-hearth," but their advent was practically coincident. For convenience, the latter will be described first. By this process pig iron of a suitable quality is melted on the hearth of a reverberatory furnace, and then either wrought-iron "scrap" or iron ore is mixed therewith.

The principle of the "open-hearth" process was well understood by metallurgists for many years before it could be carried into practice, owing to the impossibility of securing a sufficiently intense and continuous heat in any ordinary form of reverberatory furnace. As early as 1824, M. Bréant* stated that "it would be possible to produce cast steel on a very large scale in reverberatory furnaces by following a process analogous to that of the depuration of bell-metal—that is to say, by adding to the metal in fusion [pig iron] a portion of the same metal oxidized, or, still better, natural oxide of iron." In 1845 Josiah Marshal Heath (who invented the use of manganese in melting steel in pots) patented a method of making steel in large quantities by melting cast and wrought iron together upon the open hearth of a reverberatory furnace; and, for the purpose of preventing the contamination of the metal by the ashes of solid fuel, he designed to heat his furnace by jets of gas. But the experiments of Heath, although pointing out clearly the road to success, were not themselves successful. M. Alfred Sudre patented in England, December 31, 1858, a method of melting steel in a reverberatory furnace. He made experiments in 1860 and 1861 near Paris, the expense of which was defrayed by the Emperor of the French, but they fell short of a commercial success. It was not until 1864—forty years after the original suggestion of M. Bréant—that the making of steel by the fusion of pig iron and wrought-iron "scrap" on the open hearth of a gas-fired reverberatory furnace could be regarded as commercially and technically successful. This result was attained by a combination of the "regenerative gas furnace," then recently invented, with the perseverance and technical skill of Messrs. Émile and Pierre Martin, who, notwithstanding its failure in other places, erected one of the Siemens furnaces in their works at Sireuil, France. Evidently there was a lurking doubt in the minds of the Messrs. Martin, for this furnace seems to have been so constructed that, if it failed as a melting, it would succeed as a heat-

* Annales de Mines, 1824.

ing furnace.* Nevertheless, they succeeded in producing in it cast steel of excellent quality, of a variety of tempers, for which they were awarded a gold medal at the French Exhibition of 1867.

The success of the Messrs. Martin, together with the fact that patents had been granted them for certain details of manipulation, brought about a combination of the interests of the Messrs. Siemens and Martin in the process, which has come to be known as the "Siemens-Martin open-hearth process." The construction of a small furnace for conducting this process is illustrated by Figs. 55 and 56—the first being an elevation showing the "ingot molds" arranged in order upon a traveling carriage, *k*, by which they are successively brought under the "tapping spout," *b*, to

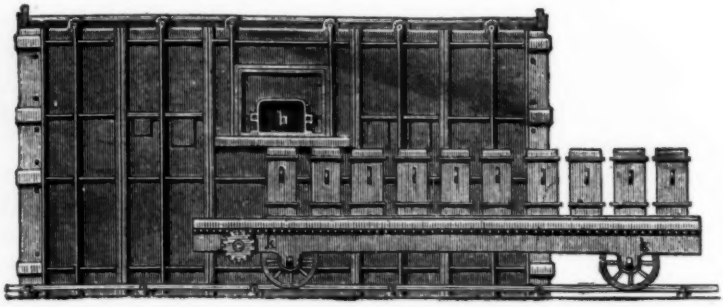

FIG. 55.—ELEVATION OF AN OPEN-HEARTH FURNACE.

be filled. Fig. 56 is a vertical cross-section, taken through the "charging door," *a*, and the "tapping spout," *b*, of the same furnace. Beneath the melting chamber will be seen the "regenerative checker-work," C, C, whose function and operation are the same as in the "pot melting furnace" already described.

The earlier "open-hearth" furnaces were like that illustrated, quite small, making but two or three tons of metal; but at the present time there are a number in operation of upward of twenty tons capacity, equipped with much more perfect apparatus for casting ingots than that shown in the engraving.

To the Hon. Abram S. Hewitt is due the credit of introducing the "Siemens-Martin" "pig and scrap" process into this country. While serving as one of the United States commissioners to the Paris Exposition of 1867, he became favorably impressed with the merits of the process, and sent Frederick J. Slade to Sireuil

* In this connection we are reminded of a hunter, who, on his weary way home without game after a hard day's tramp, thought he saw through the gathering mists of evening a deer entangled in a thicket; but, as he raised his gun, his companion suggested that it might be a calf. "All right," said the hunter, "I'm going to aim so as to kill it if it's a deer and miss it if it's a calf." A great many guns have been so aimed by hunters for metallurgical "game," but it is quite safe to say that they oftener killed the "calf" than the "deer."

to study it in detail. In 1868 Mr. Slade built for Cooper, Hewitt & Co., at Trenton, the first "open-hearth" furnace constructed in America, which was put in operation in December of that year. The process made slow progress for several years, and we find that in 1874 there were but 7,000 net tons* of steel made in that way in the whole country; but from year to year the manufacture has increased, until in the census year ending June 30, 1880, there was reported 84,302 net tons, which we find augmented to 504,351 net tons for the census year ending June 30, 1890.†

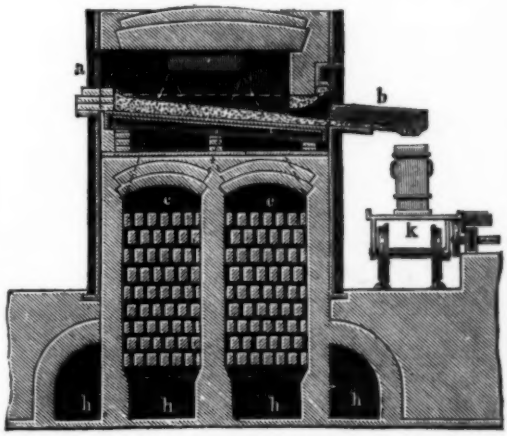

FIG. 56.—VERTICAL CROSS-SECTION OF AN OPEN-HEARTH FURNACE.

Within recent years there have been several efforts to produce "direct from the ore" "blooms" or "muck-bar" for use instead of "wrought scrap" in the open-hearth furnace, some of which give promise of success under favorable conditions of location, ore, and fuel. There have also been several attempts to make what has been very properly called "iron sponge"‡ for use in the "open hearth." Of the details of some of these it can be said that whatever was new was not good and all that was good was not new. However, it is not improbable that a good way of making "iron sponge" will yet be devised, and there are some encouraging experiments even now in progress. In the past twenty years variously contrived rotating furnaces have been invented to produce "blooms," in which for the severe manual labor of puddling was substituted a mechanical movement of the furnace itself. Some of these contrivances have had an ephemeral success, but none have won a place among generally approved apparatus.

THE BESSEMER PROCESS.

No improvement in practical metallurgy since the time of Tubal-Cain has realized such magnificent results in increasing the quantity produced and diminishing the selling price of a metal

* Swank's Annual Statistical Report of the American Iron and Steel Association for 1889.

† Census Bulletin, No. 13, Production of Steel. Report of Special Agent Dr. William M. Sweet to Robert P. Porter, Superintendent of Census.

‡ This is made from a rich iron ore by depriving it of its oxygen, leaving the metallic

as that which is known world-wide as the "Bessemer process" of manufacturing steel. In general terms the "Bessemer process" may be described as the art of decarburizing molten cast iron by blowing streams of atmospheric air into and through it.

For over three quarters of a century the germ of this wonderful process lay dormant in the "refinery fire," * awaiting the time when the needs of man should call it forth. It will be remembered that the decarburization of the molten iron in the hearth of the "refinery fire" was accomplished slowly and imperfectly by blowing air upon its surface beneath a large mass of fuel whose presence was believed to be absolutely necessary in order to maintain the heat of the metal under treatment. Had those early refiners blown the air *into* the metal, they would have been astonished to find that its temperature increased rather than diminished; that the refining operation was very much shortened; and that, if the blowing was continued for a short time longer than was necessary to make refined cast iron, the metal would become malleable—in short, they would have discovered what is now called the "Bessemer process."

Success is always perilously near to failure. All great inventions and discoveries have usually more than one claimant, and this revolutionary process is no exception to the rule—a rule which is so universal that it almost justifies the belief that when in the fullness of time the world is prepared for a decisive advance in the sciences or the arts, an overruling power indicates simultaneously to minds separated oftentimes by continents and oceans some way to satisfy the growing needs of the world, and all to whom such revelations are given, who contribute to their promulgation and success, are entitled to an honorable recognition and reward commensurate with the value of their services to mankind. The first mention of an attempt to improve the refining of molten cast iron by the action of air introduced below its surface is in an English patent granted September 15, 1855, to Joseph G. Martien, of Newark, N. J., then residing in London.† The general nature of Martien's process is thus stated in the specifications of his patent. "In carrying out my invention, in place of allowing the melted iron from a blast-furnace simply to flow in the ordinary gutter or channel to the bed or molds, or to refinery or puddling furnaces in the ordinary manner, I employ channels or gutters so arranged that numerous streams of air, or of steam, or vapor of water may be passed through and among the melted metal as it flows from a blast-furnace."

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iron as a porous, spongy mass which can be put directly into the bath of an open-hearth furnace, or be balled up in a reverberatory furnace and rolled into "muck-bar."

* Illustrated on page 328 of vol. xxxviii.

† This patent was purchased by the Ebbw Vale Iron Company soon after it was issued.

In commenting upon this patent the late Dr. Percy very truthfully says:* "It is perfectly clear from the specification that the patentee did not propose to effect by his process the conversion of pig iron, whether unrefined or refined, either into steel or malleable iron; and it is equally clear that he simply intended it to be employed as accessory to the ordinary process or processes in common use for effecting the conversion of pig iron into malleable iron. . . . The patentee emits not the slightest hint to show that he was aware of the fact that by blowing atmospheric air through molten pig iron sufficient heat would be developed to keep it in a state of liquidity, even for a very short time. Air and steam are spoken of precisely as though they were similar agents, and would produce similar effects, whereas their effects would be radically dissimilar. . . . However, in October or November, 1855, that is, two or three months prior to the publication of Bessemer's first patent, in which he first announced that he could perfectly decarburize molten pig iron by blowing air through it without the further application of external heat, the following remarkable experiment was proposed and conducted by Mr. George Parry, of the Ebbw Vale Iron Works: . . . 'In the bed of a reverberatory furnace several wrought-iron pipes, about one inch in diameter, were laid parallel to each other and about three inches apart, in the direction of the long axis of the furnace. The pipes were all put in connection with the blast apparatus. Their upper surfaces were perforated with holes about three inches apart, of which there were about eighty or one hundred altogether; and wires having been first stuck in these holes, the pipes were covered solidly over with fire-clay. When the clay bottom, thus formed, had become dry, the wires were pulled out. The furnace was very gradually heated, and then about 1½ tons of pig iron from No. 1 blast-furnace at the Victoria Works was run in, the blast having been *previously* let into the pipe. Vigorous action occurred, when, by some mishap, the molten metal escaped from the furnace into the road. The then managing director of the works was unwilling that the experiment should be repeated, and the furnace was dismantled, happily for Bessemer.'"

On October 17, 1855, Henry Bessemer (now Sir Henry Bessemer) was granted his first English patent for "improvements in the manufacture of cast steel"; other patents for improved methods and apparatus followed in rapid succession; and at the meeting of the British Association at Cheltenham in the early part of August, 1856, Mr. Bessemer read a paper before its Mechanical Section On the Manufacture of Iron and Steel without Fuel.

* Percy's Metallurgy, Iron and Steel, London, 1864.

"This paper," says Percy, "excited much attention, and was the first really public announcement of the invention." It was read in America with great interest; and it has recently become publicly known that under its stimulus the Hon. Abram S. Hewitt caused an experimental converter to be erected at the furnaces of Messrs. Cooper & Hewitt, at Phillipsburg, N. J. To an inquiry from me regarding this converter Mr. Hewitt has very courteously replied as follows:

NEW YORK, *February 13, 1891.*

W. F. DURFEE, ESQ., *Birdsboro, Berks County, Pa.*

DEAR SIR: In reply to your letter of the 11th instant, I cheerfully furnish the very meager description which is necessary to enable you to describe the introduction of the Bessemer process, so far as Cooper & Hewitt are concerned, in this country. On reading the paper of Mr. Bessemer, delivered at Cheltenham, I directed that an apparatus should be prepared at our works at Phillipsburg, N. J. The idea had been to use the ordinary blast from the furnace engines, which at the time were blowing about five pounds to the inch. I can not give you any drawing of the converter, but it was built according to the description contained in the Cheltenham paper. The capacity was about one ton. Before the apparatus was tried, Mr. Cooper went to Europe, where he ascertained that the Bessemer invention was a total failure, because the material produced was unfit for use. On receipt of this information, we suspended all further efforts to produce steel by the direct process, and, as a matter of fact, it now turns out that no steel was ever made in this experimental apparatus. So far as I know, therefore, the first actual steel made in this country by the Bessemer process was produced at Wyandotte; and, in ignorance of the fact that our apparatus was really never put in operation, I think I made a larger claim than would be justified by the facts; but you will remember that what I said was not intended to set up any claim for priority, but only to establish the fact that we were very hospitable to new ideas in the development of the steel business. Sincerely yours,

(Signed) ABRAM S. HEWITT.

This very frank letter is confirmatory of the fact (until recently undisputed) that "the first actual steel made in this country by the Bessemer process was produced at Wyandotte" more than eight years after Mr. Bessemer read his paper at Cheltenham. In 1856 Mr. Bessemer obtained two patents in the United States for his improved method of making steel; "but," says Swank, "was immediately confronted by a claim of priority preferred by William Kelly, an iron-master of Eddyville, Ky., but a native of Pittsburg, Pa."

Before speaking further of the relative claims of Bessemer and Kelly, we will explain as fully as space will permit the apparatus invented by the former, which, with slight modifications, is used wherever Bessemer steel is manufactured. The vessel in which the melted pig iron, or iron taken in a molten state directly from the blast-furnace, is transmuted into steel, is called a "converter." Fig. 57 is a vertical section of an early form of one of these vessels, which are made of heavy plate iron, and provided with a

very thick lining of the best fire-resisting material. At the bottom of the converter is a chamber called a "*tuyère*-box," from which a number of "*tuyères*" made of baked fire-clay pass upward through the lining of the vessel.

The "converter" is hung upon "trunnions" (much as cannon are), through one of which the blast is conveyed to the "*tuyère*-box"; these trunnions rest in "bearings" which, in some of the earlier converters, were on the top of tall iron stands (the base of one of such stands is seen in Fig. 57) firmly bolted to foundations of masonry; but in more modern constructions these bearings are supported by iron girders sustained by columns, or masonry piers are carried up of sufficient height to receive them. The air blast being carried through the hollow trunnion permits the turning of the vessel upon its bearings without interrupting the blast by so doing; this turning is in modern practice generally effected by some adaptation of hydraulic machinery, and occasionally by "worm" or "spur" gearing as shown in Fig. 58. The pressure of blast used was at first four to five pounds, but this was soon increased to eight, and, although there are still a few converters blown at this pressure, in the larger establishments a blast of twenty to twenty-five pounds is usually employed. Why such pressures are used, involving very heavy and expensive machinery and an excessive amount of power, is not evident, as no better or cheaper steel can be made thereby.

FIG. 57.—SECTION OF A BESSEMER CONVERTER.

The operations for making steel are as follows: The converter, after having been newly lined, is thoroughly heated by means of a coke fire built therein, and urged by a blast through the *tuyères;* when the lining is sufficiently hot, the converter is emptied, sufficient blast being used to blow out all the dust, etc. The vessel is

then turned with its body nearly horizontal, and the charge of melted iron is run in at its mouth.* The vessel is next turned so that its body becomes erect (as in Fig. 57), and, as soon as this turning commences, the blast is put on. An enormous discharge of particles of burning iron escapes from the vessel's mouth as it moves toward an erect position, and when the turning ceases it is evident that a most intense reaction is taking place between the oxygen of the air blown into the "converter" and the silicon and carbon contained in the

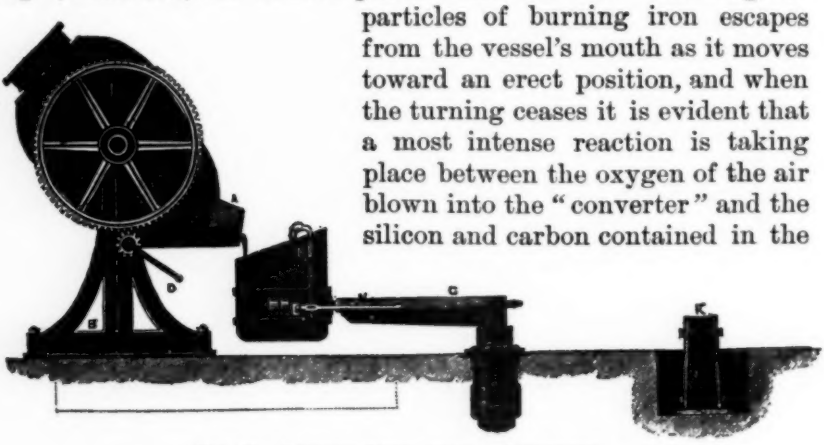

FIG. 58.—POURING STEEL FROM A CONVERTER.

iron. The mechanical action of the blast in throwing about the liquid metal augments the internal tumult—intense flame issues with an angry roar from the converter's mouth, and the whole apparatus trembles as though it was possessed of a devil that was reluctant to be cast out.

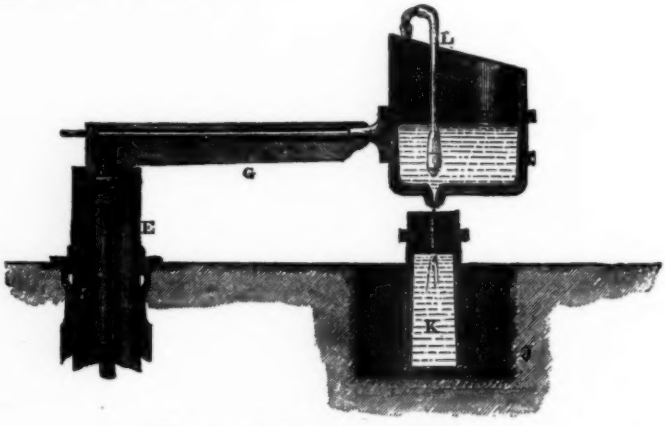

FIG. 59.—CASTING LADLE AND MOLD.

After the lapse of a certain time (varying with the character and quantity of the metal being operated upon), the flame at the mouth of the converter undergoes a great reduction in volume and change in character, and it is by the appearance of this flame

* The early "converters" had a capacity of from one to three tons, but we now hear of "vessels" holding from fifteen to twenty tons.

at this critical period of the process that the person in charge of the operation judges of the proper time to "turn down" the "vessel" and cut off the blast. When that time arrives, the vessel is turned with its body in a horizontal position, and a certain weight of a metal called *spiegeleisen* is added in a molten state, and the converter is then turned still farther down into the position shown in Fig. 58, and its contents poured into a casting ladle H, attached to the end of the arm of a crane, G. This ladle is provided with a "tap-hole" in its bottom, which can be closed by a valve attached to the lower end of the spindle L (Fig. 59). Of course, the interior of the ladle as well as the valve and its spindle are made of the best fire-resisting material obtainable. The spindle L is raised or lowered to open or close the "tap-hole" by means of a lever, N (Fig. 58), which operates a vertical slide-bar to the upper end of which the spindle L is attached. The crane-arm G is attached to the upper end of a cylindrical ram or post capable of moving upward as well as rotating in a hydraulic cylinder, E. The ingot molds (of which one is shown at K) are placed in a circle, whose center is that of the cylinder E, and are filled in succession by swinging the crane about the same center. The molds K are made of cast iron, and are smaller at the top than at the bottom, in order that they may be readily "stripped" off the ingots of steel.

The apparatus shown in the above-described figures was the invention of Henry (now Sir Henry) Bessemer. It is remarkable for its ingenuity and perfect adaptation to the needs of the new process, and, notwithstanding the lapse of over thirty years and the accumulated experience of multitudes of metallurgists and engineers, substantially the same apparatus is to-day in use in every Bessemer steel-works in the world. Of course, there have been many changes and some improvements in details, but its essential features remain as they were planned by their inventor thirty-six years ago—the converters still turn on their trunnions and receive their air-blast as has been described; the casting-ladle continues to be attached to a hydraulic crane and to discharge its contents through a valve-closed "tap-hole" in its bottom; hydraulic cranes are still used to rapidly handle ingots and molds; and these foundation facts of ingenious design promise to continue in use for all time as enduring evidences of great originality in the selection and adaptation of means to ends, and fairly entitle their inventor to a foremost place among the mechanicians of the century.

[*To be continued.*]

METAMORPHOSES IN EDUCATION.

By Professor A. E. DOLBEAR.

INSTITUTIONS are necessary for society of all grades. The Hottentot needs them as well as we and has them. In society that has been stable for a long time the institutions have been so adjusted that they are very perfectly adapted to the needs of the people, as those in China are. In a community where nothing new is learned and nothing forgotten, the mechanism for the maintenance of society runs with the least friction, and in a good sense the institutions of a country are the mechanical supports which maintain its form and give coherence to it. When one thinks of an Englishman, a German, a Russian, or a Turk, he is not thinking of one who chances to speak this or that tongue or who has this or that cast of countenance, but of one who has been molded by certain institutions in which he was brought up, and which have given to each one a personality different from any of the others, which personality has adapted him to live comfortably with an environment different from the others, and in which each of the others would find more or less that was disagreeable, and in which, at any rate for a time, he would be uncomfortable. This fitting a man for his environment is education in the large sense, and every human being is educated thus. The great difference between both individuals and nations is traceable to the breadth of the environment or the number and variety of institutions that are operative in their growth.

Wherein is the difference between the German and the Turk, that one is a synonym for civilization while the other is a symbol of barbarism and lethargy? One has been educated not only by his own institutions but by all other available ones; he has laid the world under tribute and the heavens bring to him comforts, while the other with as good opportunities has been for centuries content to shut out from himself all foreign influences whatever. His environment has been simply that of his own involuntary efforts, and it has made him a beast, as it will any who are content with less than the universe can give.

This environment of which I speak is not one of locality merely, and does not imply that the one who has traveled most is the best educated. The mountain does go to Mohammed if Mohammed commands it aright. Through literature and science all institutions are available for the one who wants them. That is a very poor education that fits a man to be a citizen content with a dozen neighbors who all do and think as he does. That is the highest and best education that fits one to be an inhabitant of the

world—a cosmopolitan who feels the Englishman or the German or the Russian to be his neighbor as much as the man who lives across the way—and if there can be a higher one still, it is that one who, if physical boundaries allowed, could traverse space and find comradeship and attractive society in Mars or the milky way.

Environment is mental as well as physical, and it too has a natural history, and in a given individual the limits of his possibilities are determined for him and not by him. This has been the result of stable institutions in the past upon successive generations, and is exemplified in the history of every people that has been subject to them. From this one may learn either that stable institutions are not desirable, or rather they are to be dreaded and fought against, or else that such stable institutions as history can show are not adapted to humanity if mankind is to have any worthy future. During the two or three centuries embracing the best days of ancient Greece, as looked at from this distance, not only was she troubled with hostility from without and with jealousies within, but nearly every individual, from the greatest to the least of them, was addicted to the grossest immoralities, which we have been and are still taught were not only scandalous and not to be tolerated, but that they are fatal to the existence of society, and so must not be tolerated. Yet Greece was not killed by its bad habits.

Since the time of the revival of learning, all those people that were subject to it sought for other influences than those of their own time and nationality to react upon them. *Each one had a barbarian for a neighbor*, but in the literature of Greece and Rome they had illustrious examples of men molded in other ways and by different methods, and these became in a measure the ideals toward which mankind should strive. The proper study of mankind was man, but the man studied should be a worthy one. The Catholic bishop declared that all the saints were dead. Inquire in any neighborhood for the wise man, and you will be told that he lives in another town. The ancient glory that could be read about was available for those who aspired for knowledge, and it soon came about that Socrates and Plato and Aristotle, Cicero and Demosthenes, Horace and Lucretius, Xenophon, Herodotus, and the rest became the teachers of western Europe. For most students and teachers it still holds true that a well-edited man, though he has been dead a thousand years, is preferable to an unedited living man, however eminent he may be. It is a great saving of time and of the risk of oversight to the schoolmaster to have the beauties, the grace, the appositeness, the truth, in an author's works pointed out by another. Until men can get along without models it is well that they choose good ones. Phidias,

Michael Angelo, Mozart, and the rest of the masters never needed them and would have wasted their time in studying them.

When educational institutions are being founded and a curriculum organized, men will and must take the best material to be had. With such data the educational scheme of the old universities was organized and it became assimilated with the religious institutions already present, and out of them grew a philosophy of education which was theological at its base. Man was a fallen being; he had originally been perfect and upright. He was not an integral part of the universe and necessarily related to it, but was a new creation, endowed in a supernatural way, but who had, unfortunately for him, lost a part of his original patrimony. If he was to better his condition his efforts must be directed to making himself like the best models of men who had lived, which could be done by becoming acquainted with their works and imitating them as closely as possible. The ideal man was the man of the past, and nothing of great importance to character was to be learned by giving attention to things not directly related to humanity. It might be convenient to know something of other matters, but it was not essential to the attainment of character or needed for the ideally perfect man. The so-called humanities consisted of a series of studies into the things that had interested the men of the past, to the end that men might become great and learned and wise and eloquent and good. In that way men could, in a degree, recover their lost estate while in this life, and be fully redeemed in the life to come.

The educational institutions became strong allies of the religious institutions, but the former were subservient to the latter. Any man who attempted to teach differently or who taught matters that were plainly at variance with such principles, though only by implication, met instant hostility from both, and the history of the times is the history of martyrdom.

Vested interests are essential to institutions of any sort and serve as their protectors. Although we can not see how it could be otherwise, yet because of it hundreds of thousands of the choicest of the race have been tortured and have perished in dungeons and in fire.

About two hundred years ago Newton published his Principia. It dealt with physical forces and their laws. It was what we would call to-day a treatise on mechanics. He discovered and formulated the laws, and, after no great contentions, they were quite generally adopted and taught as a branch of learning which it was useful to know. As it was mathematical in its character, it was of a sort that compels assent by the one who understands it; but it was adopted for what it then appeared to be, not for what was necessarily implied in its acceptance. The

implications of which I speak were not perceived until long afterward, and had these been seen by Newton or by his contemporaries, and had they been pointed out, the probabilities are that Newton himself would have joined the great band of martyrs for truth that had preceded him. It is now seen that the whole doctrine of what we call the conservation of energy is involved and implied in his laws of motion. If that had been seen in Newton's day it would have been interpreted as an attempt by Newton to dethrone the Almighty by a mathematical process, as such work has been so often stigmatized within the last hundred years. Happily, we live in the post-martyr age, and we have no fears for our lives. But while the laws of mechanism had been accepted and taught for a hundred and fifty years, they were taught mostly as abstract propositions or as applicable to appreciable motions of inanimate matter, not at all as applicable to such a problem as the formation of the earth and of the solar system. So, when Laplace developed the nebular theory on the basis of Newton's laws, the attempt was denounced as impious and tending to overthrow all religious teachings; but the multiplication table holds good, no matter who denounces it or for what purpose; and now, after the lapse of three quarters of a century, men have become able to contemplate the nebular theory without danger of vertigo, and the proposition that the solar system has been evolved from a nebulous mass through the operations of simple mechanical laws is held by all astronomers and others capable of rational effort. When it was perceived that energy existed in several forms, and that these were transformable into each other and stood in quantitative relations to each other, another mechanical step was taken, for the chemistry and geology of the earth were brought under physical laws and relationships, but it was still held that all this could be granted as applicable to inorganic matter, without trenching at all upon the idea that life, and especially mankind, held divine prerogatives, and were not to be included as a part of the general scheme of the development of the earth. The educational institutions were hostile to these various advances, and decided that if true they were premature and not proved, even long after they were accepted by those competent to judge; but, so long as life and humanity were not involved in the problem, they did not need to feel much concern. And wherever, in any college or university in the land, the above advances in physical science were taught or mentioned, it was always with the carefully added statement that it was all outside of humanity, its interests, its hopes, or its fears, and that the statements made by other persons who taught differently in scientific matters were untrue, and were instigated by hatred to Christian beliefs and the institutions founded and maintained by

them. Now there have been skeptics in all ages and upon all matters, some giving reasons and some not. Everybody is a philosopher, whether he knows it or not, and consciously or unconsciously makes every new fact or experience fit into his theory of things; it must be explained in accordance with the principles recognized by him and supposed to be known. Experience of mankind and the tricks of jugglers have made it easy to believe that all phenomena may be explained by personal agency of some sort, and to most persons that water should run down hill is no more of a surprise or mystery than that a juggler should be able to take four dozen eggs out of a borrowed hat, while to the physicist the first is an unaccountable phenomenon. It is this easy philosophy that gives so great a following to spiritualism. It is so much easier to understand than physical laws and movements, and is in such complete accordance with human experience of the lowest grade, that it is easier to imagine an immaterial personality that can be summoned to tip tables and rap on the floor, than it is to understand how the laws of energy must be recognized and can not be infracted.

Educational institutions as well as all others were founded upon a philosophy of things that presumed that the human mind was not necessarily related to anything in the world; that therefore its training could be best provided for by supplying ideal standards of excellence in those matters considered of most importance; these were studied chiefly for their gymnastic effects, and therefore best fitting a man for any career, but more especially a professor, a minister, a lawyer, or a doctor. It was true that many men attained to the highest eminence without the slightest aid from such institutions and without any of the gymnastic culture, but the argument was that they would have been better and have done more if they had had it, that it would have saved them valuable time. Inasmuch as the evidence goes to show that those who achieve success without such aids in this way do as much as an equal number educated the other way, it is plain that there is something wrong in the premises.

The world has been often surprised within the past two or three hundred years, but it generally takes a generation or two to discover the occasion of the surprise. The world is now aware of its surprise at the geological theory of the earth, of its surprise at the nebular theory, and at the Copernican theory.

The year 1859 was the year for another surprise, and it is just beginning to be perceived how great was the occasion for surprise. To be sure, the announcement of the theory of natural selection and that of the survival of the fittest aroused instant hostility, and bitter attacks were made upon it for a long time—all without the slightest effect in staying the acceptance of it. The surprise con-

sists in the discovery by the world in general that it is true. Through enormous labors during the past thirty years the science of biology has covered the ground once supposed to be peculiarly the domain of mind, and the natural history of man, both body and mind, are so well known in their most general features that the biologists of every country are agreed that man is an evolved animal, that his lineage can be traced back into the geologic past and to an animal pedigree. In mind and body he has an ancestry reaching into time indefinitely remote, and those who hate to believe it are silenced by the evidence and no longer strive against it. Their only hope is to show reasonable grounds for the belief that Nature has in some way and at some time been supplemented, and that man has some arbitrary mental gifts that can not be deduced from his natural history. This acquired knowledge of the natural history of man has revolutionized every former conception of him, and has rendered worthless—absolutely worthless—almost everything that has been written. Not only physical science, but especially history, philosophy, psychology, ethics—all had to be rewritten, and all *educational institutions founded upon these, as most all have been*, have got to be metamorphosed to adapt them to the knowledge which has been acquired in this century and mostly within the last half of it. The case is precisely similar to the history of astronomy. After the Copernican theory was found to be the true theory, the overthrow of the Ptolemaic was complete. There could be no compromise between the two: if one was right the other was absolutely and irredeemably wrong, and there was nothing but complete surrender to the Copernican theory by every one who had any knowledge of the Ptolemaic system. It had to be complete and unconditional. The teachers of the Copernican theory may have been wrong in many of their statements concerning planetary matters, and some of the Ptolemaics may have been able to point out such errors, but such failures did not give any countenance to the Ptolemaic theory; they only showed that the details of the new science needed more careful investigation. The whole of astronomy had to be rewritten; the only things of any value that had been recorded were that an eclipse occurred on such a day at such a place, or a comet was seen, or an occultation, but the reasonings and deductions by the observers were of no account.

So in like manner, if evolution be true, it follows that all previous philosophizing upon history, philosophy, education, or science, is of no more account than the reasonings of the Ptolemaics. And one to-day will not be advancing himself in knowledge by perusing the volumes of the pre-evolution age. They can not help him, no matter how ably they are written. Nor does it follow that because objectors are able to point to errors in the

works of those who are doing their best to interpret Nature on this basis, that the views of the objectors are more tenable, though there are too many who for some reason imagine that, if an author can be found to be in error in some point, his fundamental principles are not trustworthy. That would be as if Kepler should condemn the Copernican system when he found that the planets move in elliptical orbits instead of circular ones, as was assumed by Copernicus, and should say that Copernicus "would talk pretentiously about matters that he knew nothing about."

The astronomer pays no more attention to old theories of his science than he does to astrology. He even says of Kant's presentation of the nebular theory that he gives no reason for it that an astronomer is bound to respect. No chemist to-day needs to know or care what anybody thought about chemistry before Dalton. No physicist to-day needs to know or care what any one thought of electricity before Faraday. Even Franklin's opinion carries no weight. In heat Rumford and Davy are the first whose opinions have any value. In biology nobody appeals to Cuvier or Agassiz. Psychology was revolutionized by the publication of Mr. Spencer's works in 1855; and the other day Ferrier was honored in England for his work in the localization of mental faculties. The new sciences of ethnology and comparitive philology have also revolutionized all notions as to the history of mankind. Histories of the past, written within the last fifty years, are of no more account than the stories of Herodotus and Diodorus about the Egyptians and Assyrians.

About twenty-five years ago Lenormant, the French historian, announced as nearly ready for publication a history of India. In 1870 he notified the public that he had abandoned the work, having made the discovery that most of the data he had collected were worthless and that it was impossible to get anything that was trustworthy. Henshaw, of the Anthropological Society of Washington, declares that the languages of the Indians of this country, of which there were fifty-eight linguistic families and three hundred dialects, north of Mexico, at the time of the discovery of America, are none of them related in any way to Asiatic tongues; also, as to the origin of the Indian, it must have been in ages so far removed from our own time that the interval is to be reckoned, not in years of chronology, but by the epoch of geologic time.

Again, what shall we think on religious matters when a man like Le Conte states that we are on the verge of a profound and radical change in the basis of Christian beliefs; when Rev. Dr. Martineau, whose life has been spent in the defense of historic Christianity, concludes as the result of his best endeavors to discover the truth, and whose hopes and wishes and expectations

were all in its favor, that the Christ of the Church is unhistorical; when a man like Clifford says he parted with Christian beliefs "with such searching trouble as only cradle faiths can cause"; when a historian like ex-President White, of Cornell, declares that the anthropologists have destroyed the whole theological theory of the fall of man!

The significance of all this lies here. Our institutions of learning were all founded upon theories of life, of mind, of society, of history, which have broken down. There is not a single one that has stood the test of modern science, and disintegration set in some time back. It came first in a demand that colleges should furnish a knowledge of matters that books and periodicals were teeming with, and for which there was no provision in the curriculum. It came from those who objected to fooling away their time in the study of languages that had proved their unfitness for the needs of mankind, and so had perished from off the face of the earth; who objected to be forced to the study of history that was not true. A sop was offered by some institutions in the shape of scientific courses where instruction was given in the new sciences—physics, chemistry, geology, etc. These, however, were treated in a most unworthy manner by text-books and discourses instead of by practice; second, as if they were topics unrelated to each other, and thus, having no necessary relations to other matters held to be of much greater importance; and, third, the men who pursued them to the exclusion of the old curriculum were snubbed and made to appear as of an inferior grade. Under such circumstances, what should be expected but an educational failure? The institutions, *as institutions*, felt a profound contempt for the new demand, apparently considering it a kind of craze which in a little time would die out, and matters would settle back into the historical ways which time had honored and experience approved. As we now know, nothing of the kind happened, for the very good reason that the old curriculum and the new knowledge were incompatibles. The new knowledge was not and could not be assimilated by the adherents of the old. Amalgamation to any extent was impossible, and compromise was equally impossible, for the new has destroyed the foundations of nearly everything the old held to be true.

What wonder, then, is it to-day that educational institutions show such visible signs of fermentation! Metamorphosis is taking place rapidly. Among schoolmasters one hears a good deal about pedagogy, but the pedagogy is a mongrel, a kind of cross between a theory built upon experience with minds fed on abnormal diet, and a metaphysics as extinct as the dodo. I feel like advising all such to go to Clark University and study psychology.

The pedagogy which is in consonance with the new psychology

has not yet been written, and can only be known to one who is well grounded in modern psychology.

At the outset I spoke of education as fitting a man for his environment. Every man ought to know what kind of a universe he is in, what his relations to it are, what and where invariable conditions are imposed, what in the nature of things is possible and what impossible, within what limits all his achievements must be, and hence what ideals he may consistently cherish that his work may not be in vain. It hardly needs to be said that neither literature nor art nor history nor theology can acquaint a man with these. Only science can do it—science not as a mass of facts, but as a body of relations. If there be anything that the ordinary man is markedly deficient in, and which the best schooling has not added to his mental equipment, it is his failure to see the *necessities* of relation. Exercises in logic and the study of mathematics have been supposed to qualify a man to be logical, but if by this is meant that for every effect to be explained an adequate cause must be assigned, then most men are unequal to the occasion. What should be thought of the man who believes that the character of the weather for the next month is determined by the position of the horns of the new moon, or of the supporters of the pretensions of Dr. Gary and of Keely—some of them are not only college-bred but have reputations for business sagacity quite out of proportion to their knowledge of possibilities. Now, the study of mathematics as it is conducted to-day fails to develop a very strong sense of the necessities of mathematical relations, for the reason that most of it is symbolic and the symbols are not translated into experience. On the other hand, geometry is well calculated to induce in one an unshakable belief in such necessities; but this subject is neglected, while algebra and other symbolic processes engross the time and attention to the detriment of the student who goes no further than his prescribed studies. I know of a college president who a few years ago denied the validity of simple arithmetic processes when the numbers rose to millions! Now, most men have beaten into them in their business lives these necessary relations about which I am speaking, so far as their own business is concerned, and there is no trusting to superstitious factors, for superstition is but a belief in an inadequate cause; outside of their business their judgments are untrustworthy. But physics and chemistry, when pursued in the laboratory, present in a tolerably simple form relationships in an invariable and quantitative way, and the student learns by experience that, where certain conditions are, a certain result will follow with rigorous exactitude. Familiarity with facts of this class leaves him with the consciousness that among physical and chemical phenomena, wherever they occur, there is always a quantitative as well as a

qualitative relation, so that, given the antecedent, he can determine the consequent, and *vice versa*. Now, the point to this is that it is of application wherever such phenomena occur, that for the past and the future they *must* hold good for the same reason that the multiplication table must hold good. If, however, the student goes not beyond these sciences, he has not learned half his proper lesson. In physics the phenomena are relatively simple. In such sciences as those called natural history the complexity of phenomena becomes very great. Exactitude is not possible to the degree it is in the former studies, and judgments must be formed on different grounds from those. Here there are estimates and probabilities to be considered, and a degree of caution in forming a judgment, not called for in the simpler sciences. There are principles he has got from these physical sciences which he must carry into the more complex studies, viz., that complexity does not impair the certainty that the laws of matter hold true wherever matter is. He is prepared in a good measure to say what can not happen, but not so well prepared to say what may happen. These sciences then act as a check upon hasty deductions; but both of them enforce the idea of continuity, an idea which is very vague in most minds, and is the source of no end of confusion among so-called philosophers.

Again, the science of life contributes to a proper discipline in still other ways. Here one meets with phenomena in which effects are not to be measured by the amount of the acting agent. Consider Koch's consumption-cure: the thousandth of a grain injected into the circulation not only presently brings about great physiological disturbance, but actually locates itself and does its work in diseased tissue in a distant part of the body, yet affects nothing if the body be healthy! Here is a contingent result which is a characteristic of organic phenomena. So to continuity and complexity there is needed a knowledge of contingency in phenomena. By themselves biology and geology, and indeed all the complex sciences, tend to render vague the idea of necessary relations; but when to a knowledge of them is added a knowledge of physics and chemistry, a judgment formed upon an involved question will certainly have much greater weight. Lastly, there is the necessity for a knowledge of psychology. A true understanding of the acts of individuals or communities can not be had without the knowledge of the laws of mind. Every question of a sociologic nature presupposes this as the condition for intelligent action, and it is for the lack of this preparation that all the mistakes in legislation, in schemes for education, for charity, as well as those that men have made in interpreting history, are due.

An adequate knowledge of psychology can not be had without a knowledge of the brain, its functions and relations, and this im-

plies a knowledge of biology, and biology has its foundations in chemistry and physics. I do not think there is any one whose opinion one would care for who disputes these relations, but the necessities of them there are many who do not see; they are those whose ideas of physical relations are misty and unsound.

These are the essential things that every man ought to know whatever else he may know, for they have to do with the every-day life of every man. With them he is best prepared to act wisely in every calling in life, and without them right acting is a haphazard affair, as one is likely as not to be at war with the nature of things, even when his intentions are irreproachable. The stars in their courses fought against Sisera, but Nature never begins a contention. When one is initiated, she never asks for the character of the litigant. No distinction is made between ignorance and intention, piety and depravity, and no contention is ever settled by compromise, it is always an unconditional surrender. These are therefore the things that a college should teach, whatever else it might offer. But these are not to be learned from books. They must be got at first hand to be useful. It may be noted that these things are not to be learned so much for the facts presented as for the relations implied, though a true relation is as much a fact as any illustration of it can be. The law of gravitation is as much a fact as water running down hill is, and the continuity of phenomena is of vastly more importance to the race to know than all the mental efforts of the race before the time of Newton. If once accepted it dominates everywhere.

This is the condition of things that confronts us. The past has already been broken from, whether all are conscious of it or not. Its great ones are no longer our teachers and leaders in knowledge. The point of view of human affairs is not only changed, but there is demanded a change in the ideals of the race. Science has given us a new heaven and a new earth. The education of the past has proved not only inadequate, but wholly incompetent to train a mind so that it can assimilate or appreciate genuine knowledge. The names of those who have built up this new body, with few exceptions, can not be found on the registers of the great schools. Does it not appear to the disadvantage of the great schools that the discoveries which have so revolutionized men's ways of thinking and doing were nearly all made by men who had few or no opportunities for school education? To name but a few, think of Watt, of Stephenson, of Dalton, of Faraday, of Joule, of Huxley, of Spencer, of Franklin, of Henry, of Edison. There are no corresponding names to stand beside them for attainments, and the record of the exceptions is mostly for stupidity in the school work, while the opposition and hindrance to the general reception of new truth in any field have always been

due to those educated in those schools, which shows that they were not only incompetent judges, but that they had no criterion of truth, and therefore did not recognize it when it was plainly set before them. The end of this is at hand. The old will be transformed. Metamorphosis is easier than creation. The grub has already entered the chrysalis stage, and the process of transition may be heard by the attentive ear. The custodians know that something serious has happened, but they try to console themselves with the hope that the same old grub will appear with all its essential features unchanged, while the observer of processes knows that when it emerges, its former friends will not identify it, for it will be not only different in form but will be adapted to life in another sphere and to be nourished with a different kind of food, and as soon as the sunlit air has dried out its wings it will surely fly from the grounds of its former protectors, unless they shall provide flowers in the place of leaves.

THE RIVALRY OF THE HIGHER SENSES.

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PROBABLY no subject presents to the psychologist and the physiologist a greater number of unexplored regions than that of the senses and the organs of sense. As yet we do not know how many special senses we possess. To the traditional five are now added the muscular sense, about whose organs there is no little dispute; the temperature sense, including separate end-organs for sensations of heat and cold; and the now problematic sense of equilibrium, whose organs are thought to be the semicircular canals. Still less is known about the senses of animals. Some of these, as has been shown, are sensitive to colors, sounds, tastes, and odors to which the human sensorium does not react. Most interesting are the patient experiments of Sir John Lubbock, proving that the eyes of ants are sensitive to the ultra-violet rays of light. To them, therefore, even "white" light is not white. "The familiar world which surrounds us," says Lubbock, "may be a totally different place to other animals. To them it may be full of music which we can not hear, of color which we can not see, of sensations which we can not conceive." The presence of doubtful sense organs in animals, such as the muciferous canals of fishes, strikingly suggests the limitations of science; for we not only do not understand these organs, but perhaps never can understand them, as such sensations may be outside the range of our possible experience.

Returning to the human body, we find that very little has been said about the relation of the senses to each other, the order of their development in the evolution of the race, or the present tendency of their relative development. The theory proposed by Democritus, that all our senses have been evolved from the sense of touch, seems likely to be established by biological studies. But it may be more accurate to say that all the senses are specialized forms of a primordial sense, which may have been less like our sense of touch than that of sight. In this connection one recalls, and with somewhat less skepticism, certain recent experiments of the French investigators in abnormal psychology, showing that hypnotized subjects see and hear with their finger-tips.* With the growth of intelligence, there has been a steadily increasing use of the two senses which give us the finest discriminations and the widest knowledge of our surroundings, viz., the senses of sight and hearing. When each animal was obliged to search for and select his own food largely by smell and taste, the latter senses were no doubt the best developed. For tones, colors, and form these animals had little care. They thought, as far as they thought at all, in images of taste and smell, as we think in images of sight and hearing. Many animals now are smell-minded, and in the thoughts and dreams of dogs and deer we may suppose that images of odors are as prominent as visual images are in our own. In man the crude organs of taste and smell have given place to the delicate eye and ear, both as avenues of knowledge and as sources of higher pleasures. What is true of taste and smell is true also of touch. Not confusing this with the muscular sense, the information we get from the sense of touch is small and the pleasure less. That this sense is capable of such remarkable improvement in the case of the blind is evidence only of its once greater use.

It is not now my purpose, however, to compare the senses of sight and hearing with the lower senses, but with each other. It is, perhaps, not realized by many that there are certain new conditions in modern life and certain innovations in our system of education that are bringing the eye into unprecedented importance in comparison with the ear and the other organs of sense; that this greater relative use of the sense of sight will result in its greater development, while the lessened use of the sense of hearing will lead to its deterioration. Such a result would not only threaten several noble fine arts connected with the ear, and incidentally weaken the memory, but would also effect an important change in man's personality. I will try to point out the

* See Hystéro-épilepsie masculine: Suggestion, Inhibition, Transposition des Sens. By Prof. Fontan. Revue Philosophique, August, 1887.

prevailing eye-mindedness of our times, together with some of its causes. A moment's observation of our own stream of thought will show us how largely it is made up of visual images. Any one may easily verify for himself what the experience of deaf-mutes has proved, that thought is both possible and common without language, though this has so often been denied. It is quite true that ear-minded people, with small visualizing power, carry on much of their thinking by the symbolic imagery of words. Most people doubtless do their more abstract thinking largely through these convenient media, though Galton suggests that abstract ideas are, after all, only generic images, composite photographs, as it were, of the various individual things of our experience. At any rate, if we examine our own minds we see that what goes on there is, for the most part, a ceaseless flow of images of concrete things, and that of these images the visual ones are in a vast preponderance over those of the other senses. Even the word *image* suggests a visual form, and *imagination* should mean derivatively the reproduction of such forms. In our abnormal mental states—such as dreams or the delirium arising from fever or drugs—our experiences are visions rather than sounds. In our dreams we see much and hear comparatively little, while it is still rarer to dream of tastes and odors. The congenitally blind are, of course, exceptions to this rule, while blind deaf-mutes, like Laura Bridgman, dream in terms of what senses they have, and there are other exceptions. There are "voices" occasionally as well as "visions," and ear-minded people dream less, no doubt, in visual terms. But the dreamer is the "seer," as our very language shows.

Now, there is, in the nature of mental life, no reason why our images should be drawn so largely from the sense of sight. It is an accidental circumstance, due to the fact that we use the eye more than any of the other organs. The difference is both quantitative and qualitative. Our ears, to be sure, are never closed, but if we note the character of our auditory perceptions, we see that little attention or intelligence is needed in this direction. The significance of what we hear bears no comparison with the significance of what we see. In every-day life the principal office of the ear is the apprehension of spoken language. The limited and ever-repeated vocabularies of our verbal symbols call for little discriminative use. Thus far the ear is a drudge, carrying lifeless symbols to be interpreted. Even the spoken word is by many persons mentally turned immediately into the visual image, either of the thing represented or the printed or written word. On the other hand, some people, in reading, mentally represent the spoken word, but it is the motor representation of the *spoken* word, not a sensory image of its sound. The intelligent hearing of music

forms a notable exception to the usual mechanical action of the ear, yet in the life of the average man the time given to music is comparatively insignificant.

The eye is not only more active, but its action is more intelligent. It brings us into closer relations with the outer world. It gives us not a time series of single elements, but a constantly changing space series of numerous elements. It is the constant and normal interpreter of our outer life. By its means we select our food, recognize our friends, detect our enemies, guide our steps, and co-ordinate the movements of our arms and hands in eating, drinking, writing, reading, sewing, weaving, cooking, washing, plowing, planting, building, painting, drawing, driving, rowing, fencing, and in innumerable other manual dexterities. In all these movements our actions have become automatic—that is, they are directed reflexly by the muscular sense, but still always need some assistance from the higher senses, and the sense used in almost all cases is the sense of sight. For instance, with closed eyes we can write, but imperfectly. A practiced musician may play with closed eyes, but commonly, even in this art pertaining to the ear, the eye is busy, glancing at the keys and following intently the printed score. So far has our eye-mindedness gone that we use the word "see" not only for purely intellectual perception, but even for perception by the other senses. We say that we *see* the fallacy of an argument, or we *see* that the paper is smooth, or the orange sweet, or even that the piano is out of tune, when we mean that we understand, or feel, or taste, or hear.

Now, in the use and relative importance of the two higher senses there has been a marked change even in historic times. It is possible, indeed, to trace the evolution of the eye during the last two thousand years, and to discover some of the causes producing the change. The ancient Greeks, for example, were ear-minded. By this is not meant that the sense of hearing was at that time absolutely more prominent than the sense of sight, but relatively so. Notice, then, how the Greeks used the ear, with its complementary organ, the tongue, while we use the eye and the hand. They were a conversing people; we are a writing and reading people. With them poetry was sung or recited; with us it is read. They conducted politics in the Agora; we in the newspaper. Success in political affairs depended with them largely upon oratory; with us but slightly. The instrument of philosophy and discussion was with them conversation (dialectic); with us it is the monthly or quarterly review. With them music was the most prominent branch in popular education; with us it is least so. Although the principle of Greek education was harmony of all the physical and mental powers, we have only to

glance at the educational system at Athens to see the comparative unimportance of eye education. In the training of Athenian youth, next to gymnastics, music received the most attention, and grammar—the remaining one of the three elementary subjects—included learning as well as reading the poets. Music included not only singing and playing upon the cithara and lyre, but also the cultivation of poetry. Music and poetry, again, were not cultivated as fine arts by the wealthy and leisurely classes merely, but were a part of the very life of the people. They were composed, too, upon the tongue, not upon paper, and they were apprehended and learned by the ear, not from a score or book. Even the laws were taught in song at Athens. Law and tradition, music and poetry, even arts and sciences, were transmitted orally from one generation to the next, apprehended by the ear and stored in the memory. In earlier times, when writing was not in general use, codes of laws, Homeric poems, and Vedic hymns were transmitted orally and accurately from generation to generation. Instruction in those days did not come through the cold medium of a book, but directly through the living words of parent and teacher This constant use of memory and reliance upon it gave it strength, and a man's learning, if limited, was at least in his head at command and not in his library. Compare modern fiction with that of other times. Then stories were told, not written; and listened to, not read. To say nothing of the training it gave the memory, was there not something more humanistic in the social company of story-tellers and eager listeners than in the modern writing and reading of novels? Now, the novelist alone in his study tediously composing and the reader alone in his room mentally devouring the printed page present phases of life that are unsocial, if not unhealthful and unnatural.

In the "good old times" men depended for their knowledge upon what they had either learned for themselves or heard and remembered. Now we depend, to a great extent, upon our libraries and books of reference. We quote the writings now, not the sayings of great men, and do not come directly under their personal influence. In this respect there has been a great change even within a century, as books have multiplied and students are gathered less in the literary centers. As an example of our dependence on written authorities, may be mentioned the popular apotheosis of Webster's and Worcester's dictionaries. The old worship of the Bible seems to have been weakly transferred to the dictionary. In buying one of these books a person congratulates himself if, by paying a trifle more, he gets a supplement with a universal pronouncing biographical dictionary or gazetteer, forgetting that it is better to become acquainted with the works of one great man than to know when five hundred great

men were born and how their names were accented; and that it is better to go and visit one range of mountains or large city than to learn by staring at a map where all the cities and mountains are.

Our prevailing eye-mindedness is further shown by the readiness with which the mind is impressed through the eye, and the ease with which visual images are retained. A teacher, wishing to impress some essential point, illustrates or even writes the same upon the blackboard. A child who has been *told* a hundred times, without result, to correct some fault, finally learns the new way at once when presented to him by sight or touch. In physics, mechanics, and mathematics the so-called "graphic method" is used more and more. When other forms of illustration fail, we fall back upon the visible curve. The sociologist lays down his abscissas and ordinates and illustrates to the eye by curves the relation of the increase of crime to the scarcity of corn. Many teachers believe that the pedagogical discovery of our age is that it is easier to impress the mind through the eye than through the ear. This is undoubtedly true, and such teaching is successful, if by success is meant the mere imparting of instruction, so that it is understood and retained. In every subject the blackboard is freely used, and in many has become indispensable. The old-fashioned mental arithmetic has given place to the so-called "practical" arithmetic, a name which seems to be a misnomer, since the student of it is, for the rest of his life, committed to the use of pencil and paper for any mathematical computation higher than the multiplication table. Grammar even is taught by diagrams, and logic by circles. Blackboards, maps, and charts cover the walls of our school-rooms; globes, figures, models, chemical and physical apparatus, cover the tables. This constant appeal to the eye, prevails not only in our intermediate schools but also in our Kindergartens and in our colleges. In the former, instruction is by *object-lessons*. Excepting some exercise in singing, all the instruction is in form and color and in manual training. The student thus trained with respect to his eye and hand from the primary to the high school, selects, when he enters college, subjects for which he is best prepared. These are the material sciences and arts with their experimental laboratories, and their visible and tangible material and apparatus. In our colleges and universities, therefore, we notice the yearly increasing prominence given to the material sciences and to branches of technology, and the crowding out of the time-honored humanistic studies. These so-called "liberal arts," studied for subjective culture rather than for objective utilities, have, during the whole history of education, figured as the central and principal group of studies in higher education, and still do so to

a large extent in our older colleges and in European universities. Among the subjects thus contracted by the pressure of the material arts and sciences may be mentioned mathematics, studied as an end, not as a means; logic, the science of thought; ethics, the science of conduct; classical literature; music, the most cultivating of the fine arts; and, to some extent, history and politics. Language is much studied, but more for utility than for culture. Hence Greek and Latin give way to the modern languages. But even language does not check our eye-mindedness. Here, if anywhere, one would suppose that the ear and tongue would be trained. Curiously enough, it is again the eye and hand. Greek and Latin are usually studied by sight. We learn to read them and possibly to write them, but not to understand or speak them. This is to some extent true also of modern languages. The French and German learned in our schools and colleges are the written rather than the spoken languages. Strange though it is, since language is the rightful inheritance of the ear and tongue, and is the very groundwork of our social life, that our young people should be found studying it silently in their several places, thumbing their pens and their printed dictionaries, yet the explanation is not far to seek. We are a reading rather than a speaking people, and the written language is of more use to us than the spoken. We care more to be able to consult French and German books than to converse with French and German people. To be sure, there is at present a wide-spread movement among language-teachers to correct this evil; but, as a fact, language is studied in the same old way, and few students seem to understand that a language is not known unless it is known to the ear and tongue.

If now we seek the causes of our prevailing and increasing eye-mindedness, we shall find them chiefly in the invention and rapid extension of printing, engraving, and photography. These are the arts that have drawn so heavily upon our visual resources and made it so easy to dispense with the ear and the memory. The yearly increasing time given to reading and writing, compared with the time given to listening and speaking, is apparent to everybody. The present generation is a book-and-newspaper-reading generation. We get our politics from the daily paper, our art from the magazine, our science from the text-book, our amusement from the novel, our gossip from the biography, our facts from the cyclopædia. We speak of the man of education as the "well-read" man. He reads, of course, extensively in some special subject connected with his work or profession. As a foundation for this, however, he has read some standard works in mathematics, or philosophy, or physical science, or history, or philology. Of the classical writers he has, of course, read a few, such for instance as Shakespeare, Milton, Goethe, Schiller, Byron, Wordsworth, Burns, Ten-

nyson, Browning, Longfellow, Bryant, Poe, Dante, Virgil, Horace, Homer, Hume, Gibbon, Macaulay, Motley, Prescott, Bancroft, Livy, Herodotus, Cicero, Carlyle, Webster, Irving, Emerson, Pascal, Voltaire, Ruskin, Plato, Kant, Mill, Darwin, Spencer, Scott, Dickens, Thackeray, Cervantes, Hugo, George Eliot, Bulwer, Kingsley, Hawthorne, Brontë, Black, Collins, Dumas. Besides these, or many like them, he has read a great number of contemporary writings, including novels, travels, biographies, essays, philosophy, science, and art. New books, reviews, and articles, relating to his profession or specialty he must, of course, be constantly reading. Besides these he must at least glance over some of the leading articles in the best of the hundreds of weekly, monthly, and quarterly periodicals, magazines, and reviews. Then there is his private correspondence with daily letters to read and write. With all this mass of reading, however, he might not become quite a reading machine, and might find a little time for the use and cultivation of other bodily organs than the eye, were it not for the daily paper. The tireless steam press ruthlessly grinding out some thousand large pages per hour has become a kind of tyrant rather than a servant of man. By what curious perversion of modern conscience have we learned to believe it our daily duty to read that A. B. robbed a bank in New York and that C. D. wrote a book in Boston, that E. F. married a wife in Maine and that G. H. killed one in Missouri, that the weather is colder in California and warmer in France? But if we have learned to skip the crimes and casualties, we consider it our bounden duty daily to scan at least the field of politics. What one reads others must write and print. Day and night, therefore, editors, reporters, correspondents, and printers are busy with eye and hand.

As a result partly of our eye-mindedness, partly of our conditions of life, a number of arts both æsthetic and useful have sprung into being or into new life, which promise still further to increase the use of the eye. Among these we may mention the art of decoration exhibited in architecture; in the internal embellishment of dwellings, churches, and public buildings; in dress, unless we rank this as a separate fine art; in stage decoration, in floriculture, and in many other ways. There is next the art of illustration, which has enormously increased the circulation of certain classes of books, magazines, weekly and even daily papers. Then there is photography, an art which has lately received a wonderful expansion, made popular on the one hand by cheap and rapid processes, on the other hand applied to the highest scientific purposes. No less have drawing and designing extended their fields in every direction. Type-writing as a brand-new art has sprung into existence; and, finally, the art of advertising has gained a distinctive place, scores of pages in a single magazine being covered with

these silent but fascinating appeals to the eye. In all these and in many other ways the eye and the hand are called into ceaseless and intelligent use, while the ear and the tongue are idle.

There are, or at least there were, three good old arts involving the use of the ear and the tongue—namely, music, oratory, and conversation. If, as the Greeks believed, the highest good be the harmonious exercise of all our powers, there are no other arts whose loss or deterioration at the present time society could so ill afford. Of these, music is the first in worth and fortunately has suffered least thus far from the decline of the organs upon which it depends. But music, although carried to a high degree of perfection by specialists, has no longer its former place in the home and in the life of the people. Musical instruments are many, and a kind of solitary, eye-and-hand music is common enough. Contrast also the influence of the opera and theatre. The people prefer to go to the latter to *see* rather than to the former to *hear*. Notice, too, the tendency to make both the theatre and the opera spectacular to meet the popular demand for something to please the eye, so that we go even to the opera to see rather than to hear. When Richard Wagner substituted the "musical drama" for the opera, it was not merely an innovation in music nor a union of all the arts of the stage, but rather a surrender of the language of sound to the language of form.

In its three most distinctive fields, oratory is suffering a considerable deterioration. These are the pulpit, the bar, and the legislative hall. The preacher no longer tells his hearers what he knows, but reads to them what he himself has read from the commentary or the review. The widely bemoaned decadence of the pulpit is not alone due to the decay of theologies, but also to the loss of that on which its vitality depends—power to speak and to listen. Listening, too, is a lost art. At church we are often engaged in an intent review of our own mental images; in conversation we are not so busied apprehending what is said as considering what we shall say. When we wish, therefore, to attend to and remember an address or lecture, we find both difficult. In the practice of law oral pleading has been superseded to a considerable extent by the type-written brief. In our legislative assemblies the machinery of the caucus and committee-room has taken the place of the direct oral appeal.

The last of our voice arts is conversation. A recent writer in The New Review, in an article on Talk and Talkers of To-day, calls in question the "commonplace of social criticism" that conversation is a lost art, and instances Mr. Charles Villiers, Mr. Gladstone, Lord Granville, Mr. Morley, and Lord Salisbury as talkers who may be compared with Sydney Smith, Macaulay, Lord Derby, and Bishop Wilberforce. But one might well ask whether

these are talkers of to-day or yesterday. Good talkers no doubt there are even in the younger generation, but in comparison with the number of scholars of the day the number of good talkers is pitifully small. What men know they have acquired for the most part through the eye, and such knowledge is not in form to be brought out readily through the mouth. This is a generation of readers, writers, thinkers, experimenters, inventors, but not of talkers. Under our present conditions of life we may expect conversational power to decline still more than it has done.

In conclusion, it may be asked what the effect of our eye-mindedness is and will be upon the memory. Psychologists no longer speak so much of the memory as the memories. With the greater use of the eye, the eye-memory will gain; with the lesser use of the ear the ear-memory will lose. Practically, however, our present mental habits are destructive of our retentive powers generally. To the vast number of visual impressions made upon the mind daily, it is impossible to apply the two principal conditions of good memory—attention and repetition. Newspaper reading may be taken as a good illustration of our memory-destroying habits. In a half-hour devoted to "glancing over" a bulky newspaper, many thousand visual impressions may be received. To the sensations themselves we pay no attention, and usually but little to the words or to the thoughts represented. The matter we read is not worth careful attention nor any repetition. We retain little or none of it and do not care to. An item that we may wish to retain for future use is perhaps cut out and pasted in a scrap-book, and, lest we fail even to remember where it is, our scrap-book has an index. The eye-educated man is found to be well posted in a subject, provided he has a day's notice in which to "cram" from his note-books and library. Nothing suffers so much by disuse as memory. The memory age is past. The merchant has found a better way of keeping his accounts than in his head. Everywhere a man's necessary knowledge far surpasses his retentive capacity. Some will say that this is merely an incidental change in the direction of our mental activity due to our changed conditions of life, and indeed an economical change. Any real deterioration of memory, however, would be a loss of mental symmetry for which there could be no compensation.

In our present enthusiastic devotion to the eye it is not alone the symmetry of the mind that is threatened nor the voice arts alone that will suffer. It may be that we are neglecting that which is in itself one of the richest sources of good. It has not yet been shown that the world of form is more worthy of our cultivation than the world of sound. "There is something as yet unanalyzed about sound," says Mr. Haweis, "which doubles and intensifies at all points the sense of living: when we hear we are

somehow more alive than when we see. Apart from sound, the outward world has a dream-like and unreal look—we only half believe in it; we miss at each moment what it contains. It presents, indeed, innumerable pictures of still life; but these refuse to yield up half their secrets."

EXERCISE FOR ELDERLY PEOPLE.

By FERNAND LAGRANGE.*

THE tissues and organs do not all mature at once in man. It results that when we reach mature age our capacity for some exercises has notably diminished, while for others it has preserved its complete integrity. At forty-five years the bones and muscles have lost none of their solidity and vigor. The aptitude for exercises of force and bottom continues. But we can not conclude from this that the man is as apt in all forms of exercise as he was at twenty-five. While the motor apparatus proper is not sensibly modified in the maturity of life, particularly if one has kept it up by regular practice, this is not the case with some other apparatus that begin to decline earlier—notably with that for the circulation of the blood. The heart and the arteries, in spite of the most rational exercises, lose with age a part of their serviceableness, because they lose some of their normal structure.

After thirty-five years of age we recognize, even in conditions of perfect health, a tendency to sclerosis, a defect in nutrition that lessens the suppleness of the vessels and causes them to lose a part of their elastic force. This change, which goes on with increasing age, has received the picturesque designation of the "rust of life." Rust in a machine is the result of a lack of work, while deterioration of the blood-vessels is connected with the working itself of the human machine; it is the result of the wearing out of its most essential wheel-work, and it is to be observed most prominently in men who have carried exercise or work to the point of abuse. All directions for exercise in mature age, all precautions to be taken in its application, are controlled by this great physiological fact of the lessened capacity of the vessels to support violent shocks. This imperfection of the arterial system is the cause of a considerable tendency to shortness of breath; and it is by this shortness of breath that the man's diminished capacity for resistance is shown.

The differences in the structure of the arteries, even though they may not be carried so far as to denote disease, make the man

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of fifty years much more vulnerable than the young man; and vulnerable in precisely the organ most essential to life. It is, in fact, the heart that suffers in case of forced exertion, the consequences of a deficient elasticity of the arteries. Every beating of the heart represents the piston-stroke of a force-pump, and the blood-vessels are the pipes through which the liquid flows to carry life to the furthest molecules of our body. But these vessels are not inert conductors; they are endowed, in a healthy condition, with an elasticity which permits them to react at each pulse of the heart, swelling under the pressure of the sanguineous wave, and then contracting and returning to the liquid the impulse which they have received from it. The liquid, striking upon the wall of a fully elastic artery, does not suffer at once the arrest which it would suffer on meeting a rigid wall. A billiard-ball, driven against a very elastic cushion, rebounds with nearly as much force as it had when it started. An artery which has lost its elasticity is, as to the column of blood that comes against it, as an ivory ball to a cushion that does not spring. And as the billiard-player must strike more vigorously upon the ball to make it perform its run when the cushions do not spring, so the heart, when the artery has lost its elasticity, must exaggerate its effort at the systole to enable every molecule of blood to traverse the circle of the vessels and return to its point of departure. In short, the less elastic the arteries, the greater the effort the heart has to make to secure equal work. Each heart-beat, then, of a man whose arteries have become old, is the occasion for an excess of labor by the cardiac muscle. The increase in expenditure of force passes unnoticed if the beatings retain their normal slowness, but becomes very sensible when they are quickened. There are some exercises which cause the number of heart-beats to double in a few moments. The resultant fatigue of the organ, which has already been brought to the point of overwork by the continual excess of work it has had to do, is easy to conceive.

The most natural consequence of fatigue of the heart is a momentary diminution of its energy; and when the organ is weakened, the impulse it gives to the blood is no longer sufficient to cause it to traverse as rapidly as it ought the vessels through which it circulates with most difficulty, either on account of their narrowness, or of the mass which is precipitated into them at once. Hence what are called passive congestions of the internal organs, and particularly of the lungs. Congestion of the lungs is a frequent consequence in elderly men of exercises which accelerate to excess the rhythm of the pulse, and is shown by shortness of breath. This, which is more prompt in men habituated to physical exercises, is one of the first symptoms of arterial dete-

rioration. It is a warning which it would be a grave imprudence not to heed.

The elderly man should therefore give up all exercises of speed like running, and all those in which energetic efforts are added to speed, like rowing in matches. We see men of exceptional powers of resistance continuing to practice exercises of speed till they are forty-five years old; but it is well to know how indulgence in championship feats late in life usually ends. Many affections of the heart are consequences of exercises or labors that exaggerate the effort of that organ in men who have reached maturity. The central organ of the circulation can not be subjected without danger to excessive work, when its play is not seconded by the elastic force of an unimpaired arterial system; when it is partly deprived of the re-enforcement which is lent it by these contractile channels, the office of which in the circulation of the blood has been happily described by giving them as a whole the name of the "peripheric heart."

All men who employ animals in work know how their speed falls off with increasing age. Race-horses are withdrawn from the track shortly after they have arrived at the full possession of their force; they are still good for competitions in bottom, and are capable for many years yet of doing excellent trotting service, but they can not run in trials of speed. Man's capacity to run likewise decreases after he has passed thirty years; and the professional couriers who are still seen in Tunis, running over large distances in an incredibly short time, are obliged to retire while still young. Those who continue to run after they are forty years old, all finally succumb, with grave heart affections.

There are some persons who preserve to a relatively advanced age the faculty of enduring violent exercises, and of contesting with young persons in quickness of muscular work. Not long ago two men, one forty-five and the other forty-eight years old, contested in the regattas on the Seine and Marne. Their craft was called the old men's. Few oarsmen continue to row in races after they are thirty-five years old. But those whom we are speaking of, though long past the usual age for retiring, have often gained the prizes which competitors twenty years old disputed for with them. These exceptions, however, do not depreciate the force of the principles we have just explained. They prove that one may be young in spite of his years, and that the chronological age does not always agree with the physiological age. While some persons are in full organic decadence at thirty-five years, some others may not yet, at fifty years, have undergone the modifications of nutrition which are the beginning of old age. The capacity of a man for violent exercises is determined by the more or less complete integrity of the arterial tissues. Men who

preserve a degree of immunity for exhausting exercises longer than the average are those whose circulation has remained regular, and whose arteries have not yet begun to undergo sclerotic degeneration. They are really younger than their age. Every man, according to the happy expression of Cazalis, is "of the age of his arteries," and not of that which he deduces from his birth. Taking a mean, we may say that after forty years a man ought to abstain from exercises that induce shortness of breath. Instead of exercises of speed, he should adopt those requiring bottom, for which he will preserve a remarkable capacity. Race-horses which have become incapable of enduring labor that involves speed may for many years afterward perform excellent service at more moderate paces; they may even easily endure the paces of the hunt, when they have to carry their rider for the whole day, but in which the fundamental gait is not the gallop but the trot. So man preserves to the extreme limits of mature age the faculty of enduring a considerable labor for many hours, provided it is carried on with moderation. Many of the best mountain guides are approaching their sixties, and can easily tire young tourists. But everybody has remarked that the most experienced guides—that is, the oldest ones—go up very slowly, and that under that condition they can walk for an indefinite time. They do this by avoiding, through the moderation of their pace, the quickening of their pulse and the imposition of an excess of work on their heart.

In 1870, when the dangers of the invasion called all French citizens to take part, each one according to his ability, in the defense of the country, national guards of the reserve were organized everywhere, in which all those who for any reason had not been incorporated in the active service were enrolled. In the exercises of these improvised battalions, men of very unequal ages could be seen elbowing one another in the ranks. Many of them, who had passed their fortieth year, but felt themselves still "game," came to take part in the manœuvres, and were never behind in the long drill-marches. Generally, indeed, the elderly men displayed a greater power of resistance than the younger ones. But their superiority vanished as soon as the manœuvres took the form of quick movements. The "gymnastic step" was the terror of these well-intending veterans; after one or two minutes of the run they could be seen leaving the ranks out of breath, while the younger ones, whom they had left behind on the long marches, kept on for a considerable time without feeling any obstruction to their breathing. Serious accidents were sometimes produced in these movements, when they were commanded by too zealous officers who forced the men to keep up their speed notwithstanding the difficulty in their breathing; and national

guards were sometimes seen, from having run too long in the face of threatened suffocation, to fall in their places, struck with pulmonary congestion.

Exercises of force would also be as badly chosen for elderly men as exercises in speed, and for the same reason—that they fatigue the blood-vessels and the heart. Every muscular act that requires a considerable display of force inevitably provokes the physiological act called effort. A porter in lifting a heavy burden is obliged to make an effort, as does also the gymnast who executes an athletic movement with his apparatus. These are common facts of observation, and impressions which everybody has felt. If we put all possible energy into any movement, respiration stops at once, the muscles of the abdomen stretch, and the whole figure is stiffened, while the veins swell and mark salient sinuosities on the neck and forehead. I have explained the mechanism of effort in my book on the Physiology of Effort. It is enough to recollect here that it increases in excessive proportions the tension of the blood-vessels. Effort is translated, in fact, by a considerable pressure of the ribs on the lungs, and through this upon the heart and large vessels; under the influence of this pressure there is a reflow of the mass of the blood toward the smaller vessels and distention of their walls. When these vessels are tending to lose their elasticity, in consequence of the modification of structure observed in mature age, the violence to which the effort subjects them results in the aggravation of their inert state. In the same way the "fatigue" of a steel spring which has had too much to bear is increased again after every violent pressure to which it is subjected. Nothing wears out a man who has reached maturity like great physical efforts, because nothing can more than effort aggravate the effects of that defect of nutrition which is called sclerosis.

In some cases arterial sclerosis is nothing but the gradual and slow consequence of the advance of age, but assumes a rapid pace that makes it a fearful malady. In such cases we can see young persons presenting the same physiological reactions against fatigue as the elderly man. One of the first symptoms of that acute aging of the arteries which is called arterial sclerosis is the dyspnœa of effort.* All elderly men are, in different degrees, tainted with arterial degeneracy, and all ought to avoid excessive muscular effort if they would not wear out their arteries before the time—that is, would not grow old prematurely; for every man is "of the age of his arteries."

While the elderly man has less capacity for some forms of exercise than the younger adult, he has no less need than the

* See Huchard, Maladies du Cœur et des Vaisseaux, 1889.

other of the general and local effects of exercise. It is in the earliest period of mature age that the most characteristic manifestations of defects of nutrition—obesity, gout, and diabetes, in which lack of exercise plays an important part—are produced; and the treatment of them demands imperiously a stirring up of the vital combustion. Placed between a conviction that exercise is necessary, and a fear of the dangers of exercise, the mature man ought, therefore, to proceed with the strictest method in the application of this powerful modifier of nutrition. It is impossible, however, to trace methodically a single rule for all men of the same age, for all do not offer the same degree of preservation. We might, perhaps, find a general formula for the age at which the muscles and bones have retained all their power of resistance, and at which the heart and vessels begin to lose some of their capacity to perform their functions. The mature man can safely brave all exercises that bring on muscular fatigue, but he must approach with great care those which provoke shortness of breath.

The formula is thus subjective in its application, in the sense that it looks rather to the feeling of the person than to the exercise itself; and from this point of view it is exactly applicable to all. One person is taken with shortness of breath at the beginning of a fencing bout; another one of the same age can fence without losing breath, while he tires his legs and arms. Most frequently the question of measure in the practice of exercise is more important than the choice of the kind. Some exercises are dangerous only on account of the temptation they offer to impetuous temperaments to pass beyond reasonable bounds. Thus fencing, which prematurely wears out too enthusiastic swordsmen, may remain a very hygienic exercise for the man of fifty years, provided he is enough master of himself to moderate his motions. There are exercises, however, which of themselves imply the necessity of a violent effort or a rapid succession of movements; among these are some of the exercises with gymnastic apparatus, wrestling, and running. These should be absolutely prohibited to the elderly man. This rule can not be invalidated by the rare examples of men who have been addicted to such exercises till an advanced age. Such men have continued, in respect to their structure, younger than their age; they have kept their elastic arteries as other persons keep their black hair. They are physiological exceptions, and general formulas do not regard exceptions.

The need which the elderly man feels of a stimulation of his organic combustion may be satisfied in other ways than by exercises of strength and agility. It is, in fact, the sum of work that regulates the quantity of heat expended by the human body, and

that is proportioned to the quantity of tissues burned, to the amount of oxygen consumed in the acts of vital chemistry that constitute nutrition. It is possible to reach a considerable sum of daily work without at any moment making intense exertion or rapid movements. The muscular acts of exercises chosen have for that only to be continued long, without being very violent or very rapid. In other words, it is enough that the exercise represents "bottom" work.

Walking is the type of "bottom" exercise, and is the most hygienic of all kinds for the elderly man, provided it is prolonged enough to represent a sufficient amount of work. Nothing is so good for the man of fifty years as a gunning tramp, or long pedestrian tours like those the Alpinists make. But it is necessary to regard the social exigencies, which refuse to give everybody the desired number of hours, and compel another choice. There are many other "bottom" exercises that exact a larger expenditure of force than walking, without going beyond the degree of effort and rapidity that the arteries of the elderly man can safely bear. Many of what are called open-air games, like tennis, lawn-tennis, and even rowing, when practiced not for racing but as a recreation—that is, with a liveliness graduated to the respiratory capacity of the rower—provoke, for example, in one or two hours, an elimination of the products of disassimilation and an acquisition of oxygen equivalent to what one can get from eight or ten hours of walking. They permit the busy man to gain time, compensating for the shorter duration of the exercise by its intensity; but that in such a way that he can get the general consecutive effects of exercise while avoiding its general immediate effects, super-activity of the circulation of the blood and of respiration.

We ought to look also to exercise for local effects; in order, in the first place, to keep the joints supple and counterbalance the tendency to incrustation of the cartilages, which is one of the consequences of age; and, in the second place, to keep the muscles as a whole in sufficient strength and volume. The muscle, as we have read, is "the furnace of vital combustion," and in developing the muscular tissue we favor the activity of combustion and the destruction of the refuse of nutrition. For the satisfaction of these requisitions, such exercises are adopted as might be called analytical, inasmuch as they bring the whole muscular system into play, not by the work of the whole together, but by a series of successive movements that call the various muscular groups into action severally one after the other. It is important, in order to preserve the easy working and suppleness of all the articulations of the body, to subject them to movements extending to the extreme limit of possible displacement. We might also,

by localizing the work successively in limited muscular groups, effect very intense muscular efforts without any fear as to their reaction upon the organism or upon the circulation of the blood. The floor exercises of the Swedish gymnastics exactly fulfill the conditions needed to obtain suppleness of the joints; similar exercises, according to the French method, would be well fitted for the object of preserving or increasing the local muscular development.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

LIFE ON AN OSTRICH FARM.

THERE is an air of delightful unrestraint about Mrs. Martin's story of her Home Life on an Ostrich Farm.* She addresses her reader from her book as she would gossip to a confidential friend about her adventures, and describes them all with photographic vividness. We receive, as if to the very life, her first impressions of Cape Town, the Veldt, the Karroo district in which her home was situated; the farm itself, with its peculiar vegetation, birds, beasts, and reptiles; her own and her husband's trouble at not being able to realize the house of Algerian architecture which they had dreamed of; the long drought and the flood, indoors as well as out, by which it was so rudely broken; and the incidents, the humors and pleasures, mishaps and sorrows, of ostrich-raising.

Mr. and Mrs. Martin having removed to South Africa to go into the ostrich-raising business, settled on a tract of twelve thousand acres in a long valley so hedged in by steep mountains that little inclosure was necessary. It was in the part of the Karroo called the Zwart Ruggens, or black, rugged country, from the appearance it presents in the long droughts, when the vegetation turns to a forbidding black and is seemingly all dried up. But the sticks, when broken, are found all green and succulent inside, and full of a nourishing saline juice; and thus, even in long droughts, which sometimes last more than a year, this country is able to support stock in a most marvelous manner.

The little karroo plant, from which the district takes its name, is one of the best kinds of bush for ostriches as well as for sheep and goats. It grows in small compact, round tufts not more than seven or eight inches high, and, though very valuable to farmers, is unpretending in appearance, having tiny, narrow leaves, and a little, round, bright-yellow flower, "exactly resembling the center of an English daisy after its oracle has been consulted and its

* Home Life on an Ostrich Farm. By Annie Martin. New York: D. Appleton & Co. Pp. 283.

last petal pulled by some inquiring Marguerite." The *fei-bosch*, another common and useful plant, has a pinkish-lilac flower, very like that of the portulaca, and little flat, succulent leaves, looking like miniature prickly-pear leaves without the prickles. A third ostrich-bush plant is the *brack-bosch*, a taller and more graceful

SOME OF THE BEST KINDS OF OSTRICH-BUSH.—1. BRACK-BOSCH. 2. GHANNA. 3. FEI-BOSCH.

plant than the others, with blue-green leaves, and blossoms consisting of a spike of little greenish tufts. There are an endless variety of other plants, among which there is hardly one that is not good, nourishing food for the birds. "All are alike succulent and full of salt, giving out a crisp, crackling sound as you walk over them; all have the same strange way of growing, each plant an isolated patch by itself, just as the tufts of wool grow on the Hot-

tentots' heads; and the flowers of nearly all are of the portulaca type, some large, some small, some growing singly, others in clusters; they are of different colors—white, yellow, orange, red, pink, lilac," etc. They are very delicate and fragile, and fade as soon as they are gathered. The prickly pear is an introduced plant, but has become a nuisance, and brings great trouble upon the ostriches, which acquire a morbid taste for them, and ultimately succumb to the effect of the prickles that lodge in their throats and can not be got rid of.

The feathered and four-footed creatures of the country were all delightful, having the quaintest and most amusing ways, and were easily tamed; so that our settlers soon had a considerable menagerie around them. Their first acquisition was a secretary bird — Jacob — which, on first coming to live with them, reminded them "of a little old-fashioned man in a gray coat and tight black knee-breeches, with pale flesh-colored stockings clothing the thinnest and most angular of legs," the joints of which worked rather stiffly. "Not by any means a nice old man did Jacob resemble, but an old reprobate, with evil-looking eye, yellow-parchment complexion, bald head, hooked nose,

JACOB.

and fiendish grin; with his shoulders shrugged up, his hands tucked away under his coat-tails, and several pens stuck behind his ear." He was nevertheless very friendly and affectionate, and soon grew too tame and noisy. He would intrude into the house and persist in staying there, till, when all other efforts to drive him away had failed, a dried puff-adder's skin, of which he stood in mortal terror, was thrown at him, when he would run off and be gone for the day. The Cape Government protects these birds for their usefulness in destroying snakes. This one had a

voracious appetite, and an enormous capacity for swallowing lizards, rats, toads, frogs, locusts, young chickens, and kittens.

The most serious drawback to the Cape Colony as a place for settlement lies in the long droughts, which "are certainly very trying; indeed, they could not possibly be endured by any country less wonderfully fertile than South Africa, where it is calculated that three good days' rain in the year, could we but have this regularly, would be sufficient to meet all the needs of the land. But often, for more than a year, there will be no rain worth mentioning; the dams, or large artificial reservoirs, of which each farm usually possesses several, gradually become dry; and the Veldt daily loses more of its verdure, till at last all is one dull, ugly brown, and the whole plain lies parched and burned up under a sky from which every atom of moisture seems to have departed. . . . The stock, with the pathetic tenderness of thirst,

OSTRICHES IN A HOT WIND.

comes from all parts of the farm to congregate close round the house; the inquiring ostriches tapping with their bills on the windows as they look in at you, and the cattle lowing in piteous appeals for water; and you realize very vividly the force of such scriptural expressions as 'the heaven was shut up,' or 'a dry and thirsty land where no water is.' Then the hot winds sweep across the country, making everybody tired, languid, headachy, and cross. . . . Even our pets were sulky on a hot-wind day; and as for the ostriches, they were deplorable objects indeed, as they

stood gasping for breath, with pendent wings, open bills, and inflated throats, the pictures of imbecile dejection." For water-supply during these terrible seasons the farmers build dams where the waters of the thunderstorms are collected and stored. But even the most capacious lakes thus formed must dry up in a long drought;" and that land-owner is wise who does not depend solely on this form of water-supply, but who takes the precaution of sinking one or more good wells. This is expensive work, . . . but

OSTRICH-CHICKS.

the advantage is seen during the protracted droughts. Then, on farms which only possess dams, the ostriches and other stock are seen lying dead in all directions, a most melancholy sight. Where there is a well, however, the animals can always be kept alive. The water may go down rather low, and the supply doled out to the thirsty creatures may not be very plentiful; but with careful management no stock need be lost during the longest of droughts."

In the early days of ostrich farming splendid fortunes were made. Feathers were worth $500 a pound, and $2,000 or $2,500 was no uncommon price for a good pair of breeding birds, while little chicks were worth $50 each. Indeed, the unhatched eggs have sometimes been valued at the same amount. But with the larger supply, $60 may be regarded as a fair price for the best pair of ostriches, and 30 shillings, as against £25 in the old times, for the feathers of the handsomest bird at one plucking.

There are not many young animals, says Mrs. Martin, "prettier than a young ostrich chick during the first few weeks of life. It has such a sweet, innocent baby-face, such large eyes, and such a plump, round little body. All its movements are comical, and there is an air of conceit and independence about the tiny creature which is most amusing. Instead of feathers, it has a little rough coat which seems all made up of narrow strips of material of as many different shades of brown and gray as there are in a tailor's pattern-book, mixed with shreds of black; while the head and neck are apparently covered with the softest plush, striped and colored just like a tiger's skin on a small scale." As they grow they lose all their prettiness and roundness, their bodies become angular and ill-proportioned, and a crop of coarse wing-feathers sprouts from the stripes.

OSTRICH-CHICK.

The "chicken feathers" are plucked for the first time when the bird is nine months old. They are stiff and narrow, with pointed tips, and do not look as if they could be used for anything but making feather brooms. The quality is improved in the second year; but it is not till their wearer is plucked for the third time that the feathers have attained their full width and softness. During the first two years, when their plumage is all of a dingy drab mixed with black, the sexes can not be distinguished. Then they begin to differentiate; and at five years, when the birds have attained maturity, the plumage of the male is of a beautiful glossy black and that of the female of a soft gray, while both have white wings and tails. In each wing there are twenty-four long white feathers, which, when the wing is spread out, hang gracefully round the bird like a deep fringe The thighs are bare and the flat head is bald, except for a few stiff bristles and scanty tufts of down. During the breeding season the bill of the male bird and the large scales on the fore part of his legs assume a beautiful deep rose-color, looking as if they were made of fine pink coral; and in some cases the skin of the head and neck becomes red too. The North African or Bethany ostriches have bright red

thighs, head, and neck, are much handsomer than the Cape birds; and their feathers, being larger and softer and having longer filaments, command higher prices.

Ostriches are extremely nervous and subject to panics, under the influence of which they will run immoderately, often till they are lost. At plucking-time they are driven in from all the corners of the farm whither they have wandered, and collected first in a large inclosure, then in a small one, the plucking-kraal, in which they are crowded together so closely that the most savage bird has no room to make himself disagreeable. Besides the gate through which the ostriches are driven into the kraal, there is an outlet at the opposite end, through the "plucking-box." This is a firm wooden box, in which, though there is just room for an ostrich to stand, he can not turn round or kick. At each end is a stout door, one of which opens inside, the other outside, the kraal. Each bird in succession is dragged up to the first door, and, after more or less of a scuffle, is pushed in and the door slammed behind him. Then the two operators, standing one on each side of the box, have him completely in their power; and, with a few rapid snips of the shears, his wings are denuded of their long white plumes. These, to prevent their tips being spoiled, are always cut before the quills are ripe. The stumps of the latter are allowed to remain some two or three months longer, until they are so ripe that they can be pulled out—generally by the teeth of the Kaffirs—without hurting the bird. It is necessary to pull them; for the feathers which, by their weight would have caused the stumps to fall out naturally at the right time, are gone. Some farmers, anxious to hurry on the next crop of feathers, are cruel enough to draw the stumps before they are ripe: but Nature, as usual, resents the interference with her laws, and the feathers of the birds which have been thus treated soon deteriorate.

After a good rain, ostriches soon begin to make nests. The males become very savage, and their note of defiance—*brooming* as it is called by the Dutch—is heard in all directions. The bird inflates his neck in a cobra-like fashion, and gives utterance to three deep roars, the first two short and *staccato*, and the third very prolonged, the whole being described as identical in sound with the roar of the lion. When the birds are savage, or *quei*, as the Dutch call it, they become very aggressive, and it is impossible to walk about the camps unless armed with a weapon of defense called a *tackey*. This is a long and stout branch of mimosa, with the thorns all left on at the end. "It seems but a feeble protection against a foe who, with one stroke of his immensely powerful leg, can easily kill a man; the kick, no less violent than that of a horse, being rendered infinitely more dangerous by the

formidable claw with which the foot is armed." Those, however, who are well practiced in the use of the *tackey* have no difficulty in dealing with the most furious bird. They thrust the thorns in his face, and he shuts his eyes and is bewildered, and the man goes on. Fortunately, one is never assailed by more than one ostrich at a time; for, in the large camps, each one has his own domain, separated from those of the others by some imaginary boundary-line of his own, within which he defends his claims with vigor. Any other ostrich daring to invade his territory is at once attacked, and the human intruder is carefully looked out for till he is seen safely away. Immediately after thus speeding the parting guest, the most savage bird is quite harmless; he dismisses you from his thoughts, and walks quietly back, feeding as he goes. And in the distance you see the head and long neck of his neighbor, whose kingdom you have now entered, and whose sharp eyes spied you out the instant your foot crossed his frontier. He now advances toward you with jerky, spasmodic movements, as if he were bowing you a welcome; this, however, is far from his thoughts, and, after sitting down once or twice to give you his challenge—whereby he hopes you will be intimidated—he trots up defiantly, and the *tackey's* services are again required.

Thus, during a morning's walk through the camps, you may be escorted in succession by four or five vicious birds, all determined to have your life if possible, yet held completely in check by a few mimosa thorns. When an ostrich challenges, he sits down, and, flapping each broad wing alternately, inflates his neck and throws his head back, rolling it from side to side, and with each roll striking the back of his head against his bony body with so sharp and resounding a blow that a severe headache seems likely to be the result. A person on horseback is even more obnoxious to the ostriches than a pedestrian; and a ride through the camp enables one to realize how true to life is the description in the book of Job of a vicious bird: "What time she lifteth herself on high, she scorneth the horse and his rider." The creature, when preparing for an attack, draws itself up, stands on tiptoe, stretches its neck to the full extent, and really seems to gain several feet in height. The birds are very uncertain in their affections, and take sudden and unaccountable dislikes; and they are sometimes so vicious that the herdsmen have to kill them in self-defense—and as this usually happens with the finest ostriches, with considerable loss to the proprietor. Mrs. Martin had an opportunity of witnessing from her window the regularity with which a pair of birds, sitting alternately on the eggs, came on and off at their fixed times. "The cock always takes his place upon the nest at sundown, and sits through the night—his dark plumage making him much less conspicuous than the light-colored hen; with his superior strength

and courage, too, he is a better defender of the nest against midnight marauders. At nine in the morning, with unfailing punctuality, the hen comes to relieve him and take up her position for the day. At the end of the six weeks of sitting, both birds, faithfully as the task has been shared between them, are in a very enfeebled state, and miserably poor and thin." There was one hen which refused to sit, and compelled her mate to do all the work; but at the next nesting the cock gave her a sound drubbing and brought her to terms. Of another couple, the hen suffered an accident and had to be killed. Her mate mourned her long and refused to accept any other spouse; and when the period of mourning was over, and he took another mate, he allowed her to tyrannize over him and keep him in abject fear. The hen ostrich lays every other day; and if, for each egg laid, one is taken from the nest, she will continue laying till she has produced twenty or thirty. If no eggs are taken away, she leaves off laying as soon as she has from fifteen to twenty. Every morning and evening the nest, or shallow indentation in the ground, is left uncovered for a quarter of an hour, to allow the eggs to cool. The sight of nests thus apparently deserted has probably given rise to the erroneous idea that the ostrich leaves her eggs to hatch in the sun. But, "stupid though she is, she has more sense than to believe in the possibility of the sun hatching her eggs; she is indeed quite aware of the fact that if allowed to blaze down on them with untempered heat, even during the short time she is off the nest, it would be injurious to them; and, therefore, on a hot morning, she does not leave them without first placing on the top of each a good pinch of sand." The charge made against the ostrich's intelligence that, hiding its head in the sand, it imagines itself to be invisible, is declared to be false; but it does other things as foolish, and is well described in Job's words, "Because God hath deprived her of wisdom, neither hath he imparted to her understanding." Ostriches are long-lived creatures, and, however old they may become, they never show any signs of decrepitude, nor do their feathers deteriorate. Their career is usually ended by some accident; "and in about ninety-nine cases out of a hundred the disaster is, in one way or another, the result of the bird's stupidity. There surely does not exist a creature—past early infancy—more utterly incapable of taking care of itself than an ostrich; yet he is full of conceit, and resents the idea of being looked after by his human friends; and when, in spite of all their precautions for his safety, he has succeeded in coming to grief, he quietly opposes every attempt to cure his injuries, and at once makes up his mind to die." The worst and most frequent accidents by which they suffer are broken legs; and their legs are exceedingly brittle. This necessitates the crippled bird being killed, for it admits of no remedy.

At last, the family had to return to England; and, although there were not many human friends to take leave of, "there were plenty of good-byes to be said; for those who live on these out-of-the-way farms come to be on very intimate and familiar terms with their live stock; and all our creatures—even the fowls, and those tamer members of our large family of ostriches which for years had been daily looking inquiringly in at our windows, and picking and stealing round the kitchen door—were very old friends, from whom we were sorry to part." Strange to say, the animals the parting with which excited the least painful feeling were the horses. The independence and freedom of their lives make them indifferent to human society, and there grows up none of that fellowship with them that is universal between Europeans, Asiatics, and American Indians and their horses.

DRESS AND ADORNMENT.

II. DRESS.

By Prof. FREDERICK STARR.

WHY has dress been developed? We answer at once, to serve as a covering to the body. But, if we think over the matter a moment, we shall see that three different motives may have operated:

1. The desire for ornament.
2. The wish to protect one's self against weather and harm.
3. The feeling of shame.

Dress may, then, be a decoration, a protection, a covering. All three of these motives have no doubt acted, but we believe the first has been the earliest and most powerful.

Were modesty and the feeling of shame the only factors in urging on dress development we should expect to find no naked races; there should be an inflexible rule as to what constitutes modesty, and covering should always be more important than display. In reality we find the opposite of all these. "What is necessary is always less important than luxury." Ornament is never lacking—clothing often is. Peschel has somewhat fully discussed this matter of nakedness and shame. He tells us that there are tribes who, when first discovered, lived naked. Among those he names are Australians, Andamanese, some White Nile tribes, the red Soudanese, Bushmen, Guanches, some Guianians, Coronados, and the Botocudos. All these people, dwelling in a state of nudity, seemed to have no idea of shame on that account. The feeling of shame for nudity is not then universal, nor have we any reason to believe that it ever was.

It is true that all these tribes are dark-skinned people, and it is claimed by some writers that a dark skin lessens the realization of nakedness. Adolph Bastian said that his "skin appeared abnormal and by no means beautiful by contrast" with that of the dark peoples he met. Jagor said of a King from Coromandel who wore only a turban and a waistcoat, "He did not look indecent, for his dark color almost removed the impression of nudity." At Yuma, Arizona, the Yuma Apaches flock to the passenger trains and are looked at with great interest by the tourists. We have been profoundly impressed with the absolute insensibility of these ladies and gentlemen to the fact that the Indians are really almost naked. That a dark skin does lessen the feeling that a man looked at by a white observer is naked is certain. That it lessens in any degree the dark man's own perception of the fact is doubtful.

In developing the subject still further, Peschel states that there is no fixed standard for shame on account of bodily exposure. Of what one is ashamed varies with race, with style of dress, and with fashion. "The Mussulman of Ferghana would be shocked by bare shoulders at a ball; an Arab woman does not expose the hair on the back of her head, nor the Chinese woman her bandaged foot." An early traveler describes an Australian woman who wore bands of shells about her head and arms and a cord of human hair about her waist. Without this cord she felt shame; yet it was not in the least a protection or covering. Humboldt, in speaking of skin-painting among some South Americans, says, "Shame was felt by the Indian if he were seen unpainted." In these two interesting cases we strike the key-note of the whole subject—"it is the absence of the customary that causes shame." To use a homely and not original illustration among ourselves, a man who forgets his necktie and goes to business without it, on discovering its absence feels a chagrin and uneasiness quite out of proportion to the importance of the matter. We see that shame for nudity is not universal, that the standard of decency in covering the body varies, and that the feeling of shame seems to arise from the absence of what is customary. It seems to us, from these facts, that the idea of clothing as a modest covering is relatively recent, and that it is subsequent to dress development.

Nor does it seem that protection has been the chief factor in dress development. The Fuegians went almost naked even in bad weather; "a small square of skin hung over one shoulder and was simply shifted to windward." On the other hand, clothing has been developed to a very elaborate extent in many regions where the climate does not at all compel its use.

The third of the three motives mentioned remains. Dress has generally developed out of ornament. That it has, after being developed, often been turned into a modest covering and a protec-

tion is unquestioned. No people are without ornaments; many are without dress. Ornaments are of two kinds—those directly fixed into the body, and those which are attached by a cord or band. As soon as man hung an ornament on such a band, dress evolution had begun. Lippert calls attention to the fact that some parts of the body are naturally fitted to support bands or girdles; they are the temples, neck, arms above elbow, wrists, waist, legs above knee.

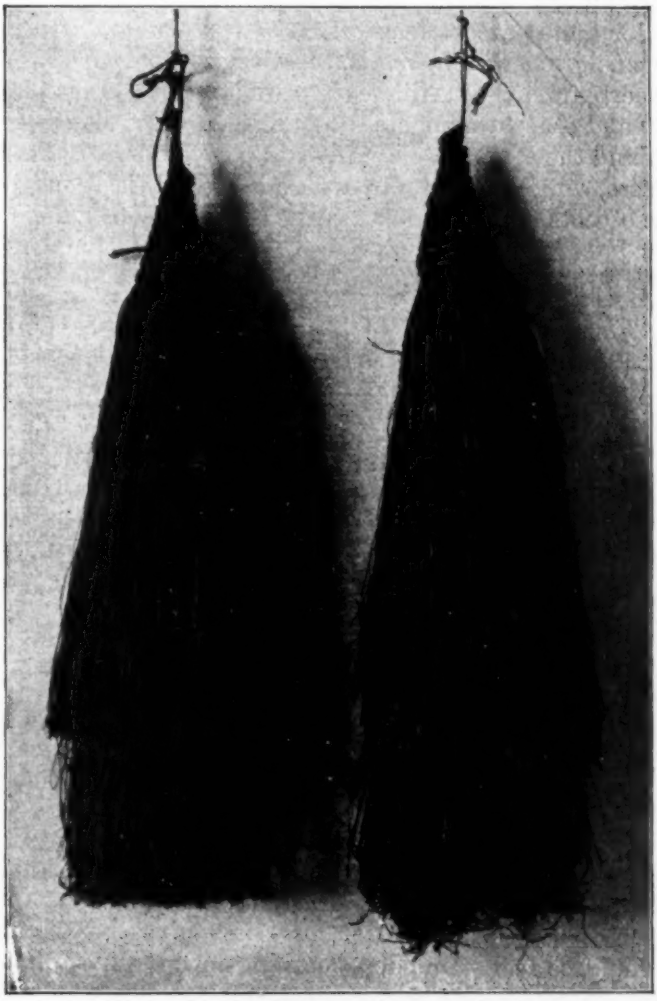

FIG. 1.—AFRICAN APRONS, WRAPPED FOR STORAGE.

ankles. There are girdles and bands of an ornamental character and in the greatest variety for all these parts. They will be described and illustrated in our next lecture. Nothing is more simple than the passage of a cord about some one of these places, and the hanging upon it of objects supposed to be beautiful.

Two of these ornament-bearers would be capable of carrying a particularly heavy load of objects. These are the neck and the loins girdles. To what extent the hanging of ornament upon these girdles is carried is shown by the following cases mentioned by Wood. A young Kaffir dressed for a visit is described as follows: "He will wear furs, among them the Angora goat; feathers in his head-dress; globular tufts of beautiful feathers on his forehead or on the back of his head; eagle feathers in fine head-dresses, as also ostrich, lory, and peacock feathers. *He ties so many tufts and tails to his waist-girdle that he may almost be said to wear a kilt.*" Of some other Africans—"Around their waists they wear such masses of beads and other ornaments that a solid kind of cuirass is made of them and the center of the body quite covered with them." In these cases, which might easily be multiplied, is it not evident that the objects hung on to the girdle are simply ornamental, and

FIG. 2.—SOUTHERN TYPE OF DRESS. Loochoo Islanders. The hair-dressing is ethnically characteristic.

that one accustomed to wearing such a mass of objects would feel shame at their absence? This ornamental mass would, with introduction of newer and lighter materials, give way to an apron which would be really a modest covering, although originating in ornament. The African apron and the Polynesian *liku* are developed from the waist-cord with its ornaments. In the same way the neck-girdle might give rise to a cape for the shoulders.

Examining the dress of the world, we can distinguish two fairly marked types which we may designate, as Lippert does, the northern and southern types of dress. The latter is really a development from just these two pieces of dress—the neck-girdle and

the loins-girdle. It has originated in and is adapted to warm climates, it is loose and flowing, it has evidently originated in ornament. It is the dress of China and Japan, of the Orient, of ancient Greece and Rome, and of old Egypt. No matter how elaborate the style or how beautiful the material, such dress may all be reduced to the two simple articles before mentioned. The northern type may have been largely due to the wish for protection against the cold, although even here the ornamental has not been lacking in influence. Perfectly developed, the type presents us close-fitting jackets and trousers with tight sleeves and legs. The first materials for this type of dress were skins, and the form of the garments is doubtless due to the fact that the skins were at first tied with thongs about the limbs and trunk. We have said that even here we find the influence of the strife for display. We believe skins were first worn as trophies. Frequently in the classics the heroes are described as wearing skins of lions or leopards. In Egypt, Diodorus says the king wore a lion's, dragon's, or bull's skin over his shoulder. In a severe climate such trophies would become protective coverings. The forms of southern dress were developed by draping, those of the northern by wrapping; but, as the body draped and wrapped was the same, we need not be surprised at finding somewhat similar garments in both series. Jackets and trousers are worn by both Chinese and Eskimo, but in the one they are loose-fitting, flowing garments, in the other close-fitting and tight.

Fig. 3.—Northern Type of Dress. Eskimo.

It is most interesting to see how, after the idea of dress was once developed, it has stimulated man's mental progress and mechanical skill in searching for better materials for clothing and devising means of using them. Let us briefly consider some of these dress materials and the ways in which they are treated to render them fit for use. Skins were employed early and are in use the world over. Schweinfurth, in speaking of his Niam-niam guides, says: "They wear large aprons, like cooper aprons, in the early morning, as a protection against dews and dampness. None of these skins are more beautiful than that of the

bushbok, with its rows of white spots and stripes upon a yellow ground. Leopard-skins are worn by chiefs only." Of the Bongo the same author says that they "simply knead and full by ashes and dung the skin for their aprons, etc.; they also apply fat and oil until the skins are pliant." Kaffirs, we are told, invite friends to help them in dressing skins. The party "sit around the skin and scrape it, carefully removing all fat and reducing the thickness. They

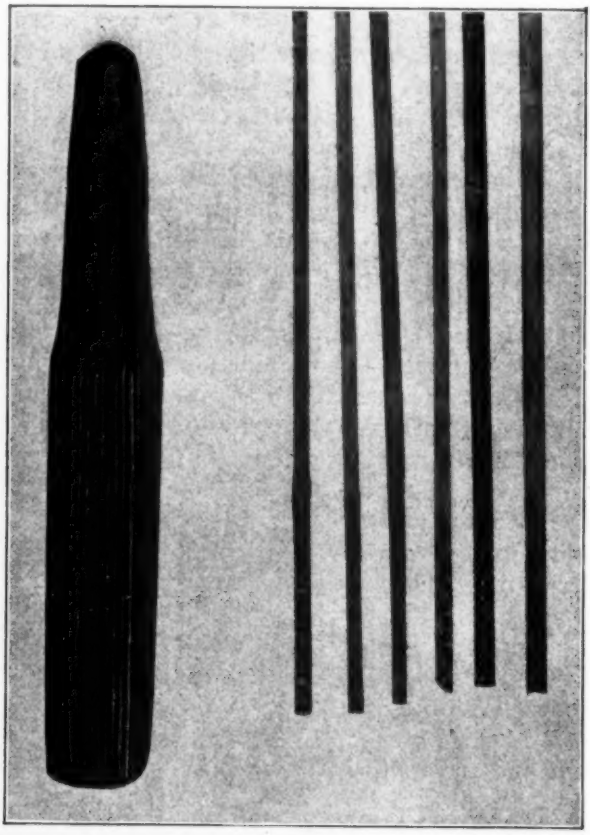

FIG. 4.—BEATING-CLUB, USED IN MAKING TAPPA CLOTH; STICKS FOR STAMPING PATTERNS ON BARK CLOTH. Hawaiian Islands.

then work it all over by pulling and stretching it over their knees. When completely kneaded each takes a bunch of iron skewers or acacia thorns and revolves the bundle in his hands, points downward, on the skin, to tear up the fibers and add pliancy and raise a fine thick nap. Powder of decayed acacia stumps is then rubbed into the skin with the hands. A little grease is then carefully rubbed in." The beautiful buckskin which our own Indians make is well known. The skin is soaked in a lye of wood ashes for some time. It is then stretched and pegged out, the hair scraped off,

and brains of deer rubbed in. Among the Eskimos we find some very handsome garments made of bird-skins. These, as other skins, are softened by being chewed between the teeth. These various cases interestingly show the beginnings of tanning.

Nature offers ready-made garments in leaves, and, where modesty *is* the motive to dress, we find them used. In New Caledonia men wear a single leaf hanging from a girdle, and in New Guinea a belt of leaves or rushes five inches wide and long behind. Kingsmill women wore a long rope of human hair two hundred to three hundred feet long, to which was hung a dress of leaves. Very interesting is the fact that at Madras, once a year, the whole low caste population put aside their ordinary garments and wear leaves. Later we shall refer to this instance again.

Nature is not always so kind as in Brazil, where, Tylor says, a man who wishes a garment goes to a *shirt tree*. He cuts a four or five foot length of trunk or large branch, gets the bark off in an entire tube, which he has then to soak and beat soft and cut slits in for arm-holes. A short length makes a woman's waist. But bark is used as a dress material widely. Throughout a large portion of Oceania the natives have their *tapa*, *masi*, or *gnatoo* cloth, made by beating the bark of the malo tree. Wood quotes the process of manufacture of the *gnatoo*:

A circular incision is made around the trees near the roots with a shell, deep enough to penetrate the bark. The tree is then broken off. It is left in the sun for a couple of days to become partly dry, so that the inner and outer bark may be stripped off together without leaving any of it behind. The bark is then soaked in water for a day and a night, and scraped carefully with shells, to remove the outer bark, which is thrown away. It now swells and becomes tougher. Being thus far prepared, beating (*too-too*) begins. This is done by a mallet a foot long and two inches thick, two sides horizontally grooved a line in depth, with intervals of a quarter of an inch. The bark, which is two to three feet long and one to three inches broad, is then laid on a beam of wood six inches long and nine inches broad and thick, which is separated from the ground about an inch by bits of wood, so it may vibrate. Placing the bark before her, the woman beats with her right hand, and moves the bark to and fro with her left, so as to beat it evenly, using the grooved side of the mallet first and then the smooth one. Women generally beat alternately and early in the morning. In about half an hour the material is beaten sufficiently thin, and has spread so much laterally as to be square when folded. They double it several times during the process, so as to spread it more equally and to prevent breaking. Thus prepared, it is called *fetage*. The second part of the operation is called *cocanga*, or printing with cocoa. The berries of the *toe* are

gathered—the pulp of which makes a paste. The root of *mahoe* is sometimes used. The soft bark of the cocoanut is scraped off and yields a reddish-brown dye. A stampis made of dry leaves of the *paoonga* sewed together so as to be of sufficient size, and afterward embroidered with cocoanut-husk fiber. These stamps are generally two feet long by half a foot broad. They are tied into

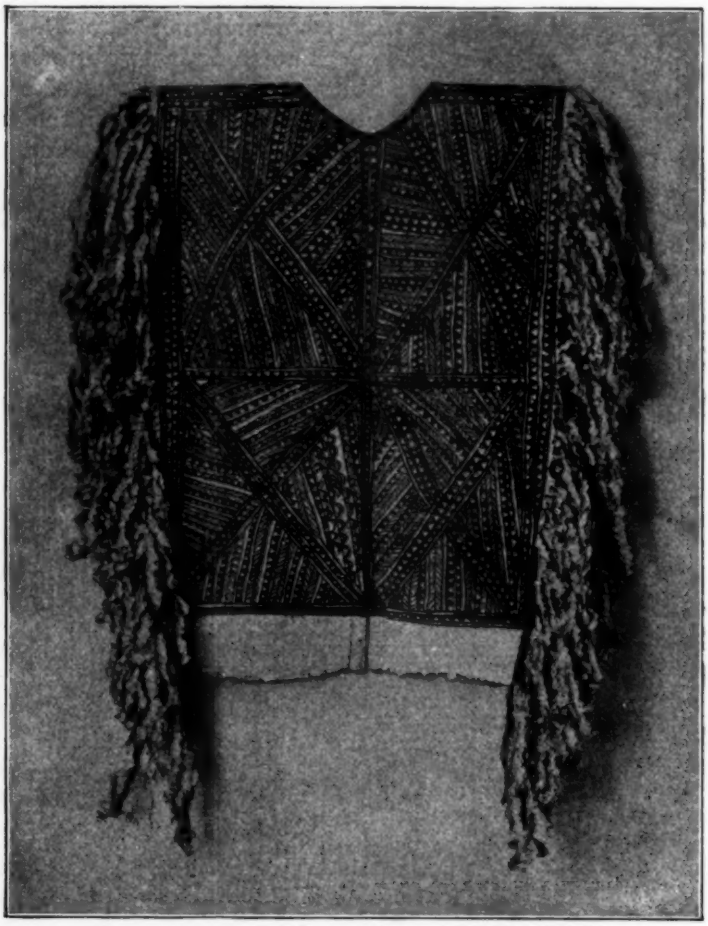

FIG. 5.—GARMENT OF BEATEN BARK. South Sea Islands.

the convex side of cylinders of wood six or eight feet long, with the pattern side up. The bark cloth is laid on and smeared over with a piece of *gnatoo* dipped in dye. Another piece of the *gnatoo* is laid over the first, so as not to exactly match it. Both are pieced out in all directions, and three layers are built, each being stained separately. The process is continued until a piece six feet broad and forty or fifty yards in length has been printed. This is folded and baked under ground, to harden and darken the dye, also to

deprive it of the smoky smell due to cocoa. When thus exposed for a few hours, the cloth is spread on grass or sand and the operation of *toogihea* begins—stamping it in certain places with the juice of *hea*, which constitutes a brilliant red varnish. This is done in straight lines, along the junctions of the printed edges, and serves to conceal irregularities. It is also done in other places in the form of round spots an inch and a quarter in diameter. Exposed to dew, and next day to the sun, it is packed for future use. When not printed or stained the cloth is called *tapa*.

Schweinfurth describes the *urostigma* of the Monbuttos, which is used much as the shirt tree of the Brazilians. He says that nearly every house has its trees, which need cultivation. He states that the removal of the bark does no harm to the tree, and that a new growth is ready in three years. He adds the interesting fact that this bark cloth is the common dress, and that *skins are worn only when in fancy dance dress.* The significance of this we shall see later.

FIG. 6.—SOUTH SEA ISLANDER WITH DRESS OF BARK CLOTH.

Besides tanning, beating bark, and felting hair, the search for dress materials and study of their use have given rise to the art of weaving. This art begins in basketry and plaiting, Seldom at present do we find plaited dress articles. Wood, however, mentions some of interest. In the lower Murray region of Australia a circular mat (*paringkoont*) made of reed ropes coiled and bound together by fibers of chewed *bulmol* is worn. It is simply folded about the body and tied at the waist. In New Zealand the native wild flax supplies a wonderfully fine material for plaiting. It is fully utilized, and nowhere do we find more elegant mat garments. Wood describes several kinds.

A mat may be made of *phormium* leaf cut into strips an inch wide, each alternate one being dyed black. Each strip is divided into eight little strips or thongs plaited into a checker-work. Other styles of "mats" are made of *phormium*. The fibers of the

leaf of this plant are strong, fine, and silky. A weaving-frame on sticks a foot or so from the ground is used in making some of these mats. Upon it is a weft of strings close together and drawn tight; the weft is double, passed under and over each yarn. A bone beater is used. Even a common mat takes eighteen months in making. All mats are ornamented with strings or tags: thus, one was covered with long, cylindrical ornaments, looking like porcupine-quills, hard, alternately yellow and black. These are made of phormium-leaf epidermis rolled up. The *kaitaka* is a peculiarly beautiful mat, soft and fine, plain except the border, which is in some cases two feet deep, elaborately woven in Vandyked patterns of black, red, and white. War cloaks of chiefs are woven in much the same way, but hair is woven in so that the mat looks like a skin. Such cost four years' labor, and no two are alike.

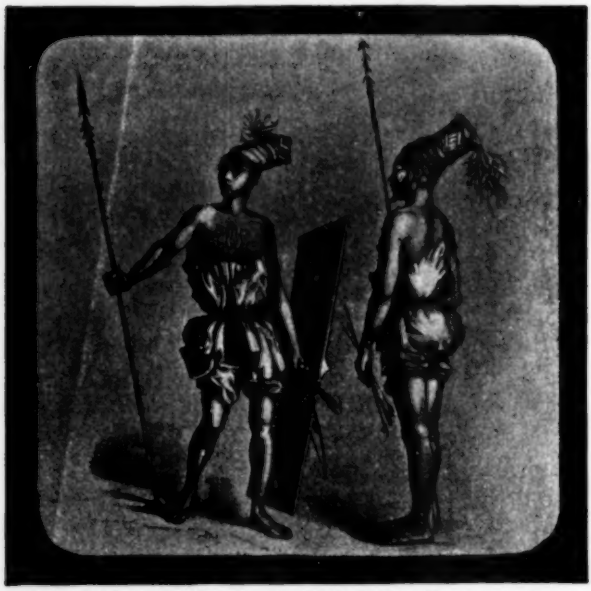

FIG. 7.—MONBUTTO WARRIORS WITH DRESS OF UROSTIGMA BARK. (Schweinfurth.)

Out of such plaiting as this true weaving grows. The only difference between plaiting and true weaving is that the splints or ribbons of the one are replaced by cords or threads. The development of the great looms of to-day has been often enough traced. A good example of their beginnings is the very simple little wooden *cibohikan* of our Sacs and Foxes.

Some of the articles of dress made by savage and barbarous peoples deserve notice. They are sometimes elegant in material and beautiful in workmanship. No furrier can do better work than does the Kaffir *kaross*-maker.

A large *kaross* is worn fur inward. If made of several skins, the heads are in a row along the upper margin. This is bent back and falls outward as a cape. Jackal-skin is prized as thick and soft, with rich black mottlings. That of the meerkat is also valued. One *kaross* of thirty-six skins was sewed very neatly;

each skin was pierced by a weapon; yet, viewed on the hairy side, not a hole is visible, circular pieces of skin being "let in." Great skill is shown in selecting these pieces, as the meerkat is extremely variable. A professional *kaross*-maker takes two pieces of fur, places them together, hairy sides in and edges just matching. He repeatedly passes the long needle between the two pieces, so as to press the hair downward and out of the way. He then bores a

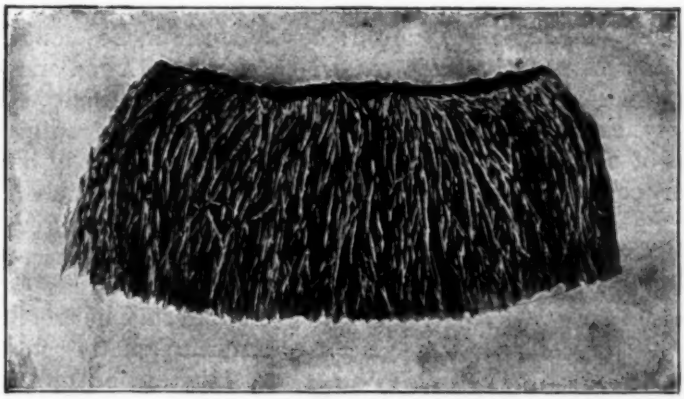

FIG. 8.—LIKU. South Sea Islands.

few holes in a line with each other and passes a sinew fiber through them, casting a single hitch over each hole but leaving the thread loose. Two or three such holes being made and the thread passed through, he draws it tight so as to produce a sort of lock-stitch, perfectly safe and neat. Finally, he rubs down the seams so that the edges lie as if one piece. The gray jackal is more prized than the black; though not so beautiful, it is more rare. One *kaross*, five feet three inches deep by three feet wide, was made of several skins. The skin is darkest along the back. The maker has here selected skins and uses the darker ones for center and lets it fade away toward the edges to give the effect of one large skin. Not only so, but by careful cutting and piecing the effect was carried out. All the heads are set in a row along the upper edge. The lower edge is made from the skin of the paws—*very* dark, in a stripe four inches wide. In some *karosses*, two feet from the top and on the outer edges, are small wings or projections, one foot long by eight inches wide. These wrap around the shoulders and arms. The *kaross* reaches the knees in front and a foot lower behind and at the sides. The edge of the *kaross* is bound on the inside with membrane band to add to its strength. This is made from antelope-skin, rolled up and buried in the ground until partly putrefied; it is then split. The needles used are like skewers and eyeless. The thread is of sinews—the best of which are from the

neck of the giraffe. Naturally, these are stiff, angular, and elastic. When wanted for use it is steeped in hot water until quite soft, and then beaten between stones. This separates it into filaments of any fineness and *very* strong. The sinew is used wet and so is the leather; when dry, the seams are very tight and close (Wood).

The Kaffir also wears an apron called an *isinene*. This is simply a waist-girdle to which are hung trophies. Though these are supposed to be tails of the leopard, lion, or buffalo, they are seldom really such. One specimen was made up of fourteen tails of twisted monkey-skin, each about fourteen inches long, finely sewed to a belt of the same material covered with red and white beads. Across the belt were two rows of brass buttons. Among the Polynesians the common dress is the *liku*, a fringed girdle of thongs of some vegetable material. These thongs may be of no greater coarseness than pack-thread, or they may be of some width and neatly crimped. Feather garments are frequently of great beauty. The finest come from South America and the south seas. A Mundurucu apron consisted of a backing of cotton string into which were worked feathers: a band of jetty black at the lower end, above it bright yellow, and then scarlet with blue and yellow pattern in it; the upper edge was set with brilliant beetle elytra. The most famous feather mantles were those made for royal use in Hawaii, consisting of mesh-work into which were worked feathers of the yellow melithreptes. Only two of these feathers were produced at one time by one bird, and the mantles were valued at an almost fabulous price. Last of these descriptions we may quote what Schweinfurth says of the costume of King Munza, of Africa, on state occasions. He wore a plumed hat on top of his chignon, reaching one foot and a half above his head. This hat was a narrow cylinder of closely plaited reeds, ornamented with three layers of red parrot feathers and crowned with a plume of the same; it had no brim; he wore a copper crescent in front. His ear muscles were pierced, and

FIG. 9.—SOUTH SEA ISLANDER WITH LIKU.

copper bars as thick as the finger were in the cavity. His body was smeared with powdered camwood. His garment of a large piece of fig bark, stained with camwood, reached in graceful folds down the body. Round thongs of buffalo hide, with heavy copper balls at the ends, hung around his waist in a huge knot and, like a girdle, held the coat, which was neatly hemmed. Around the neck hung a copper ornament with little points radiating like beams over the chest; on his bare arms were pendants, in shape like drumsticks, with rings at the end. Half-way up the lower arms and below the knees were three bright, horny-looking circlets of hippopotamus-hide, tipped with copper. In his right hand was a sickle-shaped scimiter of pure copper.

A piece of suitable material for a garment having been secured, the forms would be easily developed. We have already suggested that the close-fitting garments of the northern type of dress arose from the tying on of skins. The present forms of the southern type are almost as simple in their origin. Tylor has suggested a development of forms from the simple blanket or skin robe. The use of the blanket itself we see among many of our Indian tribes to-day. It is simply thrown over the shoulders, grasped at the sides by the hands, and drawn about the body. If the arms are extended while one wears a blanket in this way, the garment drapes in such a manner as to suggest sleeves. Among some tribes of the Southwest there is a slit made in the center of the blanket and the head is put through this. Such a slit blanket would easily become a loose-sleeved garment, like the one so commonly in use in Guatemala and elsewhere. The Sacs and Foxes in Iowa usually wear the blanket. If a man wishes free use of his hands for work, he folds the blanket through the middle to reduce its length, and wraps it tightly about his waist, tucking the free end tightly in. It thus becomes a skirt, and though skirts usually have *not* developed in this way, they *may* have done so sometimes. However a skirt arises, the convenience of a divided skirt sometimes suggests itself, and a pair of loose and flowing trousers re-

FIG. 10.—FEATHER CAPE AND MATTING BLANKET. New Zealand.

sults. Thus, from girdles loaded with ornaments and from blankets worn at the shoulders and at the waist, we can see the beginnings of all the forms of the southern dress type. Curiously enough, we ourselves preserve *both* types of dress. There are two great conservative elements in society—woman and religion. Both have served and do serve to-day as useful brakes upon rash and too impetuous change. The northern and the southern types of dress once came in conflict. The time was that of the invasions of the northern barbarians upon imperial Rome. Both men and women, in the ancient days of Rome, wore southern dress. The barbarians wore the tighter-fitting garments of their colder climate. The southern man adopted the more convenient type; the woman did *not;* and so we see to-day our men in jackets with tight sleeves, and trousers fitting close, while women continue to wear in a modified form the dress of the sunny south—flowing garments, skirts, and cloaks.

FIG. 11.—SOUTHERN TYPE OF DRESS. Japan.

We have no inclination to trace the details of the history of our modern dress. In closing, however, we do wish to call attention to some "*survivals*" in our garments of to-day. The hat-band, with its bow always on the left side, is such a survival. It exists because it once had a real use, and for the position of the knot there is a reason. A hat once was simply a piece of stuff, which was held in place upon the head by binding it with a bit of cord or ribbon. This cord, of course, was tied, and in course of time the knot became large and ornamental. It was the day of sword practice, and such a cockade upon the right side would have interfered with the free use of the weapon; hence the knot must be upon the left side. The band and knot remain, though they have long been useless. Tylor shows us that the dress-coat, the ugly and uncomfortable "*swallow-tail,*" is a survival. It is really the old riding-coat. "The cutting away at the waist had once the reasonable purpose of preventing the coat-skirts from getting in the way in riding, while the pair of useless buttons behind the waist are also relics from the time when such buttons really served

the purpose of fastening these skirts behind; the curiously cut collar keeps the now misplaced notches made to allow of its being worn turned up or down; the smart facings represent the old ordinary lining; and the sham cuffs, now made with a seam about the wrist, are survivals from real cuffs, when the sleeves used to be turned back."

We have tried to show that, while three motives have been influential in dress development, the desire for ornament has been the most powerful; that shame for nudeness, though sometimes acting, has been least potent; that two types of dress have been developed; and that *our* dress is a combination of these two. We have claimed that the desire for dress has urged on man's mental progress, leading to a search for materials and to development of the arts whereby they are made of service. We have considered some examples of dress of no mean workmanship, made by low and barbarous tribes. We have inquired how the forms of garments came to be what they are, and have seen that in our own dress much that is useless survives from the past.

ON POLYANDRY.

By Lieutenant-Colonel A. B. ELLIS.

THE numerous examples of the forms of marriage by capture which we gave in a former paper in The Popular Science Monthly will have shown how almost universal the practice of taking wives by violence from other groups must have been in primitive times—a practice which, it may be remembered, we attributed to a prevailing scarcity of women. In the present paper we purpose showing that we were right in predicating of the primitive groups that they usually contained fewer women than men, by adducing evidence of the exceedingly wide distribution of polyandry, a system which can only be attributed to a scarcity of women; for it is inconceivable that men should have voluntarily initiated a form of marriage under which two, three, or more men—sometimes as many as seven or eight—would be the associated husbands of one woman, if there was a possibility of their obtaining a wife apiece. Even if, by doing violence to our common sense, we suppose such a thing to be possible on the part of the men, how would the women submit to a state of affairs which would compel at least three women out of every four, supposing the sexes to be equally balanced, to remain unmarried? It is obvious, however, that polyandry could in its origin only be induced by necessity. There must have been fewer—much fewer—women than men; and as experience and observation show that

throughout the world the tendency is for women to be more numerous than men, it follows that, wherever polyandry exists or did exist, the balance between the sexes must have been artificially disturbed. Such a disturbance could only be effected by female infanticide, as we have already stated in our former paper.

The rudest form of polyandry is that in which the associated husbands are not necessarily blood-relations; the less rude is that in which they are brothers. The former is unquestionably the more ancient form.

The first is found among the Kasias (sub-Himalayan ranges), the Nairs (Malabar), and the Saporogian Cossacks. Apparently it was this form that existed among the Guanas (South America), for Ayasa says that among that people "careful stipulations were made as to the duties and obligations the bride undertook with reference to her husband; how far she was bound to provide him with food; whether she was to procure the necessary fire-wood; whether she was to be the sole wife; whether she was to be free to marry another man also; and in that case how much of her time the first husband wished to engage." It probably occurs at Rasaque (East Africa), for Speke mentions a case of two men having married one woman;* and it is found in the Marquesas Islands, where "no man has more than one wife, and no wife of mature years has less than two husbands—sometimes she has three, but such instances are not frequent."† In the Marquesas Islands the males considerably outnumber the females. In the Sandwich Islands the female chiefs had a plurality of husbands. Kaahumanu, one of the widows of Kamehameha, had two husbands, viz., the ex-King of Tanai and his son. A female chief named Kapiolani also had two husbands.‡ It appears that there was no limit to the number, and that the arrangement by which father and son were husbands of the same woman was not exceptional. Without insisting too much upon this instance, it seems probable that the privilege thus retained by the female chiefs was a survival from a more general polyandry; the women highest in rank being naturally those who would be able to retain it the longest.

The form in which the associated husbands are brothers has existed from time immemorial in the valley of Kashmir; in Thibet; among the Svalik Mountains; among the Spiti; in Ladak; in Kistewar and Sirmor. It is found in Gurghal, Sylhet, and Kachar; among the Coorgs of Mysore, the Todas of the Nilgherry Hills, and the Teers, Maleres, and Poleres of Malabar. It

* Discovery of the Sources of the Nile, p. 239.

† Melville's Marquesas Islands, p. 213.

‡ Journal of a Residence in the Sandwich Islands, p. 219.

is thus widely distributed in India. It also exists among the Calmucks, the Australians, and the Iroquois. Humboldt found it among the Avanos and Maypures Indians of the Orinoco, and attributed it to a scarcity of women.

Both forms exist among the Eskimos of Boothia,* and in Ceylon. Of the latter, Sirr says:† "Although when polyandry is indulged in by the highest caste the husbands are usually brothers, still a man can, with the consent of his wife, bring home another, unrelated to him, who has all the marital rights, and is called an associated husband. In fact, the first husband can bring home as many men as his wife will consent to receive as husbands, and these marriages are recognized by the Kandian laws." Sirr saw a Kandian matron of high caste who was the wife of eight husbands who were brothers. In his time polyandry was limited to the province of Kandy; but Tennant tells us‡ that it was at one time universal throughout the island, and was extinguished in the maritime provinces by the influence of the Portuguese and Dutch. Here, too, we find that the men are more numerous than the women. By the census of 1821 the number of males exceeded by twenty thousand that of the females. In one district there were only fifty-five women to every hundred men.*

Erman tells us that polyandry exists in the Aleutian Islands, and among the Koriaks to the north of the Okhotsk Sea, but does not say which form of it. It also exists in western Eskimo Land, among the Garos of the Himalayas, and the Smerenkur Gilyaks in the southeastern corner of Siberia, but the exact form of it is left in doubt.‖

We thus find polyandry existing in the present century in each quarter of the globe. That it should exist at all, considering that the conditions which gave rise to it have almost universally passed away, and that the practice itself is manifestly to the disadvantage of the males, is a matter for surprise, and is a fresh proof of how enduring is custom. Of its existence in other localities in the past we also have direct evidence.

According to Polybius, polyandry was practiced in ancient Greece, and in the twelfth book we read that it was an old established custom in Sparta, where the brothers of a house often had one wife between them. That it existed among the Celtic inhabitants of Great Britain, the well-known passage in Cæsar proves: "Uxores habent deni duodenique inter se communes, et

* Sir J. Ross's Narrative, vol. i, p. 335; vol. ii, p. 43.

† Ceylon and the Cingalese, vol. ii, p. 162.

‡ Ceylon, vol. ii, p. 428.

* Heber's Journal, vol. ii, pp. 518, 519.

‖ See Journal of the Anthropological Society, London, 1865, p. cccvi; Hooker's Himalayan Journals, vol. ii, p. 273; and Lansdell's Through Siberia, vol. ii, p. 225.

maxime fratres cum fratribus, et parentes cum liberis; sed si qui sunt ex his nati, eorum habentur liberi a quibus primum virgines quæque ductæ sunt." * In the Irish Nennius we also find direct evidence of its existence. In Media, according to Strabo, in certain cantons polygamy was ordained by law, while in other cantons the opposite rule was in force: a woman was allowed to have many husbands, and those who had less than five were regarded with contempt. Polyandry receives a partial sanction in the Institutes of Menu, and it is adverted to without reproach in the epic of the Maha-bharata, the heroine of which, Draupadi, was the wife of five Pandu brothers. It existed among the Getes of Transoxiana, the Guanches of the Canary Islands, and the Caribs of the West Indies.†

Polyandry thus can not be regarded as exceptional, since we find direct evidence of its existence among so many peoples. But, as has been said, the conditions which alone could have caused it have, in the great majority of cases, passed away: the general rule is for women to be more numerous than men, and it is therefore to the survivals from polyandry, to the practices derived from it and perpetuated through custom, that we must chiefly trust for indications of its former wide distribution. Now, one of the most remarkable customs connected with polyandry is that of a brother taking to wife a deceased brother's widow, and reckoning the children born of the new union as the children of the deceased. This custom originates from the practice, in polyandrous unions, of the children always being considered the offspring of the husband who first espouses the wife. The first husband is considered the head of the household, the family property is vested in him, and all the children are feigned to be his. At his decease the brother next in age succeeds to the headship; but as the children, no matter which of the associated husbands were their true fathers, have always been reckoned the offspring of the first husband, the practice is continued, through custom, even after his death, and children born subsequently are still called his. Thus, in Thibet, the right of choosing the wife belongs to the eldest brother, to whom also all the children of the marriage are held to belong. In Ladak, when the eldest brother marries, the juniors, if they agree to the arrangement, become inferior husbands of the wife; all the children, however, being considered as belonging to the eldest brother. Among the ancient Britons the children of the wife were accounted to belong to the husband who first married her. In Ceylon, the offspring of polyandrous unions are looked upon as the children of the first husband, and that equally

* De Bello Gallico, v, xiv.

† See Humboldt's Travels, etc., vol. i, p. 32; Desalles, Hist. Gén. des Antilles, vol. i, p. 197.

whether the associated husbands are brothers, or are not related to each other. Wherever, therefore, we find the custom of "raising up seed" to a deceased brother, we are justified in holding that the people who observe it were once polyandrous. It could not be feigned spontaneously that the children born of the new union were the offspring of the deceased brother. Such a practice could not come into being unless the people who observe it had formerly passed through a phase of polyandry, and had been accustomed to feign all the children born to the associated brothers to be the offspring of the eldest brother. The following are examples of this custom:

Among the Makololo, when an elder brother dies, the brother next in age takes his wives, "as among the Jews, and the children that may be born of these women he calls his brother's also. He thus raises up seed to his departed relative." * Among the Gallas, says Bruce,† "when the eldest brother dies, leaving younger brothers behind him, and a widow young enough to bear children, the youngest brother of all is obliged to marry her; but the children of the marriage are always accounted as if they were the eldest brother's." Among the Zulus, when a son inherits his father's property, if any of his father's widows are young enough, his uncles are appointed to raise up seed to the heir's house—that is, the brothers take the wives of the deceased brother, and the offspring of these unions are reckoned as children of the deceased. This custom, called *ukeengena*, is now, however, modified, and the widow may, if she chooses, marry some other man; but, in this case, the new husband pays a certain sum in cattle to the estate of the deceased.‡ The Kirghis used strictly to observe this custom, but among them, as among the Zulus, it is now dying out; though, should a widow marry a man in her late husband's tribe, other than her brother-in-law, the man has to pay her brother-in-law a fine for the slight done him by her preferring another to himself.*

The case of the Jews must be familiar to everyone. In Deut. xxv, 5, we read, "If brethren dwell together, and one of them die and have no child, the wife of the dead shall not marry without unto a stranger: her husband's brother shall go in unto her, and take her to him to wife, and perform the duty of an husband's brother unto her." 6. "And it shall be, that the first-born which she beareth shall succeed in the name of his brother which is dead, that his name be not put out of Israel." That this was an old custom of the Jews we know from the case of Onan (Genesis, xxxviii), where, after Onan has avoided raising up seed to his

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* Livingstone's Travels in South Africa, p. 185.

† Travels, etc., vol. ix, p. 225.

‡ Incwadi Yami, p. 39.

* Russian Central Asia, vol. i, pp. 329–330.

brother Er, and is in consequence slain, the widow, Tamar, has a recognized claim upon Shelah, the brother next in age. See also Ruth, i, where, Naomi's two sons having died, she says to her daughters-in-law, "Are there yet any more sons in my womb that may be your husbands?" and "would ye tarry for them till they were grown?" There being no brothers to take these widows, one of them, Ruth, makes overtures to Boaz, a near kinsman of her deceased husband; and this man then takes her to wife, not, however, as *levir*, but as *goël*, or redeemer of the heritage of the dead. The *goël* was not bound by law to marry the widow as a condition ,of the redemption, but it appears from Ruth, iv, 10 and 17, that when he did so the first child born of the new union was reckoned the offspring of the deceased. With the Makololo, Zulus, and others, the obligation of the levirate holds good whether the deceased had children or not; with the Jews the custom had become modified and the obligation only held good when the deceased brother was childless. This was also the case with the Hindoos at the time when the Institutes of Menu were compiled, and is the case at the present day with the Shushwap Indians of British Columbia, and other peoples.* Among the Jews, the son born of the new union, the fictitious child of the deceased brother, became the heir to the property, to the exclusion of his real father, the levir. By the Institutes of Menu the property was divided between the fictitious child of the deceased and his real father.

We have said that it is the practice in polyandrous households for the brother next in age to succeed, at the decease of the eldest brother, to the position of the head of the family, to the family property, and to the wife; and from this practice doubtless arises the wide-spread custom of a brother inheriting a deceased brother's wives. In Ladak we see that the younger brothers are not obliged to be joint husbands of the wife of their eldest brother—it is optional for them to be so or not—but the property, authority, and wife of the eldest brother devolve at his decease upon the brother next in age, whether he has agreed to the polyandrous union or not. Through the custom derived from polyandry he has a right of succession to his eldest brother's property and widow, and he can not take one without the other. In this case we see the original custom in a state of decay. In earlier times the younger brother would necessarily be a husband of the wife, and as such would, at the death of the elder brother, succeed to the position of head of the family—that is, the wife and the property would be vested in him. At the present day it is optional for the younger brother to be an associated husband, but, even if he is not one, he still

* Northwest Passage by Land, p. 319.

has the right of succession to the widow and the property. And what has occurred in Ladak has certainly occurred elsewhere. As the sexes became more equally balanced, younger brothers would prefer taking wives to themselves to being the associated husbands of their eldest brother's wife. Polyandry would die out, but the law of succession to property, stable as all such laws are, would be perpetuated through custom, and, as in the days of polyandry the heir used to take the widow with the property, so would he continue to take the two together after polyandry had disappeared.

To enumerate all the peoples among whom it is the rule for the brother to succeed to a deceased elder brother's property and wives would occupy far too much space. The custom is almost universal among the lower races, and it will be sufficient to mention a few of the most striking examples. Among the Malays, a man is not obliged to marry the widow of a brother, but if he does so he becomes liable for all the obligations of the deceased.* Here we see that to marry the widow is the counterpart of the legal right of succession to the property. Among the Afghans it is incumbent on a man to marry his elder brother's widow, and the custom is so strongly insisted upon that any departure from it is counted a scandal and a blot upon the character of the parties concerned.† Among the Shushwap Indians (British Columbia), if a man dies childless, his brother must marry the widow. In Guzerat (India), the widow of an elder brother invariably devolves upon a younger, and the law is equally imperative with the Somalis (East Africa), the Damaras (South Africa), the people of the New Hebrides, and many others. In New Zealand, Samoa, Fiji, West Africa, Mongolia, and other localities it is usual for the brother to marry the brother's widow; but if she feels any repugnance she may, subject to certain penalties, return to her own family.

In course of time, through the custom of the widow and the property always passing to the next brother, as *heir*, it becomes the custom for the heir, even when not the brother of the deceased, to inherit the widow as well as the property; and what occurs in some of these cases shows clearly that the practice is derived from polyandry. For just as the brother "raises up seed" to a deceased brother, so in some cases does the heir, even when a son, "raise up seed" to the relative from whom he inherits. Thus the Makololo chief "Sekeletu, according to the system of the Bechuanas, became possessor of his father's wives, and adopted two of them; the children by these women are, however, in

* Crawford, Dictionary of the Indian Islands, article Marriage.

† Mission to Afghanistan, p. 27.

these cases termed brothers."* That is to say, among the Bechuanas a son succeeds to his father's wives, and the children born of this new union he feigns to be the offspring of his father, and so calls them brothers. He raises up seed to the departed relative from whom he inherits. From this there can be no doubt that the custom of inheriting wives is derived from polyandry. The custom of a brother taking a deceased brother's wife is a disintegration of the older obligation of taking the wife and raising up seed; which older obligation still survives in some cases when the system of female descents has disappeared and the succession has opened to the son. The case of the Zulus is a variation. With them the son inherits the property, but the uncles take the widows and raise up seed. We thus find three phases of the system: (1) Where the succession is from brother to brother, the brother takes the widows and the property, and raises up seed. (2) Where the succession has changed to that from father to son, the son takes the property, but the brothers take the widows and raise up seed. (3) The son takes the widows and the property, and raises up seed. Finally, in all three the custom of raising up seed disappears, and the widows pass to the heir, whether he be brother or son.

Another survival from polyandry is that system of succession under which property descends from brother to brother and then to the son of the eldest brother. The system of succession from brother to brother, and then to *sister's* son, is the natural outcome of descent through females, and that from father to son is the natural outcome of descent through males; but the one from brother to brother and then to son is neither one thing nor the other. It recognizes the blood-relationship between father and son, but excludes the latter from the succession till each brother has succeeded in turn. Now this is the order of succession observed in the Thibetan polyandry: Brothers succeed one another in order of age, and, failing brothers, comes in the eldest son of the brotherhood; and the arrangement is so peculiar that we have no hesitation in affirming that, wherever this order of succession is observed, polyandry has existed.

We find this system in vogue among the Kirghiz, the Aeneze Arabs, and the Mongols; the next brother being heir even when the elder leaves issue. We have already mentioned the Kirghiz and the Mongols as observing the levirate. The same order was observed in succession to the throne of Darfour (eastern Soudan). The law was there ascribed to the Sultan Ahmed Bekr, who died about 1750; but it is less probable that it was the result of a mere enactment than that it was an established local custom. In Siam,

* Livingstone, *loc. cit.*

says Sir G. Bowring,* "on the death of a king his eldest brother succeeds; when he has no brothers, his eldest son; should he have several brothers, they succeed one another according to seniority." The levirate is optional in Siam. In Fiji brother succeeds brother, and then the succession reverts to the eldest son of the eldest brother.† It is worthy of note that all brothers are in Fiji called fathers by their nephews, just as is the case in the less rude polyandry, and that no word exists to express uncle.

Enough, however, has now been said to show how very widespread polyandry has been; traces of it are, in fact, found so universally that we are justified in regarding it as a normal phase of human progress. It can only be explained on the grounds of a scarcity of women, and that scarcity must have been felt almost universally. Hence we may conclude that we were right in our view that the early groups contained fewer women than men, and that this was the cause of marriage by capture. A number of customs which are probable survivals from polyandry lend us additional support; these we may perhaps be able to discuss on some future occasion.

THE DOGS OF ANCIENT EGYPT.

By M. G. MASPERO,
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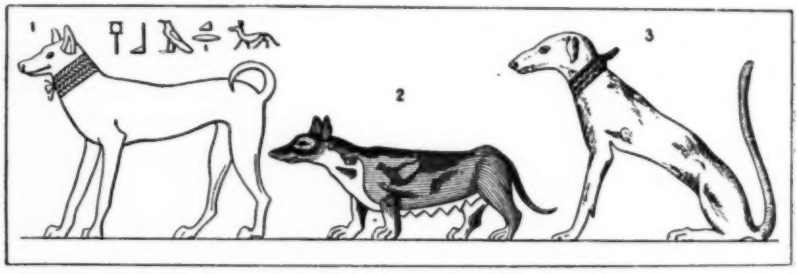
THE Egyptians domesticated the dog from the most remote antiquity. The names which they gave it—*ouhorou, ouaouou* and *tosmou*—belong to the fundamental dialect of their language; and one at least of them is a characteristic onomatopœia, such as our children instinctively use in their earliest age for the designation of the animal. It is hard now to determine what was the most ancient species they tamed; the most ancient monuments show us dogs of every size and every color, and the cemeteries have given us greyhounds, terriers, and twenty varieties more or less closely related to the jackal or to the modern fellah's dog. At the opening of Egyptian history, more than four thousand years before the Christian era, we might have met in the towns and in the country the same mixture of types and confusion of forms and colors that we observe now. The dog was in Egypt, as he is with us, a friend and a faithful servant at the same time. He lived in the house with his master, followed him in his walks, attended the public ceremonies with him, sometimes free, at others held in leash by a slave or child, or in princely families by a favorite dwarf. At meals he had his place marked under the

* Kingdom and People of Siam, vol. i, p. 96.

† At Home in Fiji, vol. i, p. 281.

benches of the guests; as in Greece and Rome, he was there to dispose of the bones, the fragments of meat, and the pieces of bread that were thrown down, and in a general way to keep the dining-room clean. These were certainly not very refined fashions, and if our house-dogs had to satisfy themselves in this way they would be likely to die of hunger. The ancients did not feel the delicate tastes and disgusts in such matters that we experience; their life presented excessive refinements and rude features of which we have no idea side by side. The house-dog in Egypt was a domestic, working at his trade, only his trade was one of those in which we have ceased to employ him; it may not have been a great thing that he has lost, but it is in the kitchen or his kennel that he finishes up his master's dessert.

The house-dog was shaved, combed, and washed; he was sometimes tinted with henna as if he were a woman; he wore fine collars on his neck, furnished sometimes with an earthenware clasp in the shape of a bell or a flower. Children played with him, became attached to him, and the hero of one story to whom his fates had predicted at his birth that he would die of the bite of a dog, willingly confronted the threatened danger rather than be separated from the dog which he had raised. He, of course, had a name, to which he answered: *Si-ŧogai*, the son of the bat; *Akeni*, the ferreter; *Khaoubsou*, the lamp or star; *Soubou*, the



FIGS. 1, 2, AND 3.—DOGS FROM THE EGYPTIAN MONUMENTS.

Fig. 1, one of the favorite dogs of King Antef, from his funereal stele. Fig. 2, bitch depicted in a Theban tomb of the twentieth dynasty. Fig. 3, hound from the tomb of Anna at Thebes (eighteenth dynasty), from a drawing by M. Boussac.

strong; and *Nahsi*, the black. He is seen with kings as well as with common persons. Rameses II, during the earlier years of his reign, was always escorted by a female dog which was called *Anaïtiennaktou*, or brave as the goddess Anaïtis. A petty king of the eleventh dynasty, about 3,300 B. C., had five dogs which he loved so much that he carved their names and engraved their portraits on his tomb They were, indeed, blooded animals whose names revealed their foreign origin. The finest one of them (Fig. 1) was called *Abaikarou*, a faithful transcription of the word

abaikour, by which the hunting-dog is designated in many of the Berber dialects. A servant is holding them behind the king, who is looking at them, and prevents their disturbing the sacrificial ceremony at which they are present.

The shepherds had dogs of medium size with pointed ears, like those which still guard the flocks of Upper Egypt. Hunters sought out two or three kinds of hounds (Fig. 3), some having straight ears and short tails, and some drooping ears and a long tail, like the *slouguis* of the modern Berbers. They are to be seen in many of the tombs, springing in pursuit of gazelles and antelopes, or running down the hare and the ostrich. A few pugs, heavy and grotesque like ours (Fig. 2), are represented occasionally, rather as house-dogs than as hunters. These animals were in considerable number, and made the ancient Egyptian villages as dangerous at night as modern villages are. An officer relegated to one of the Delta burgs a few years after the death of Rameses II complained bitterly of their boldness in a letter addressed to one of his chiefs: "When, sometimes," he says, "the people of the country meet to drink Cilician beer and go out to open the bottles —there are two hundred large mastiffs and three hundred wolf-dogs waiting all day at the door of my house—every time I go out at nightfall to take part in the feast, I am kept out if I have not with me the little wolf-dog of Nahihou, the royal scribe, who lodges with me. He saves me from the other dogs. At whatever time I go, he goes with me on the street; and when he barks I run, swinging my club and whips. It is, in fact, only a pack of the mangy, high-tailed wolf-dogs prowling around the cattle-pens. When they have made their round, the largest ones in front, in a compact mass, as if in a bunch, one would say that it was the enchantment of some god, a flame which had fixed itself and would not let go." Roving dogs are less numerous and less ferocious now, but they become at times terrible to strangers. It has oftened happened to me, when casually passing through a village of Upper Egypt about midnight, to be reminded when I met them of the bull-dog in one of Dickens's novels, "a biter of man and killer of children for sport, which usually lived on the right side of the street, but also hid itself on the left side, so as to be ready to jump upon the first passer-by." As it is under Tewfik Pasha, so it was in the time of Rameses II, and the experience of the present day enables us to understand exactly what our scribe meant in the passage I have just quoted.

The dog was a god; he was at the same time several gods, of which the best known, the barking Anubis of the Latin poets, was also a jackal. As there were cemeteries for cats, there were also for dogs, where their mummies are to be found by the thousand. I am cognizant of them at Siout, Sheik Fadl, Feshn, Sakkarah,

and even Thebes, and most of the Egyptian museums possess more or less well preserved specimens of them. One of these mummies was recently opened and drawn by Herr Beckmann, a German (Fig. 4). It was a small harrier, about eighteen months old. There is hardly anything left of it but the bones and the skin, and a few bits of muscular tissue between the teeth, reduced to dust. It had been wrapped in a wide band of coarse cloth glued to the skin by a thick layer of bitumen. Over this envelope they had applied a thin mat of dried reed-stems like those which are found on many human mummies of the twentieth dynasty and later, fastened by a long cord of braided grass. The animal, thus bundled up, presented the appearance of a cylindrical mass, or of a veritable basket of game, with both ends left open. A decent shape had to be given to this queer-looking package. A network of fine cloth was thrown over the part which answered to the body, so arranged as to design parallel rows of superposed squares along its length; a kind of ornament which is found on many mummies of small animals, as of the cat, ichneumons, the ibis, and the hawk. According to usage, the head was covered with a pasteboard mask, in which the physiognomy of the animal was reproduced as far as possible. It was painted a dark brown, except around the eyes, the lips, and the nostrils, which were white. The half-opened mouth showed the points of the teeth, and the ears rose above the head.

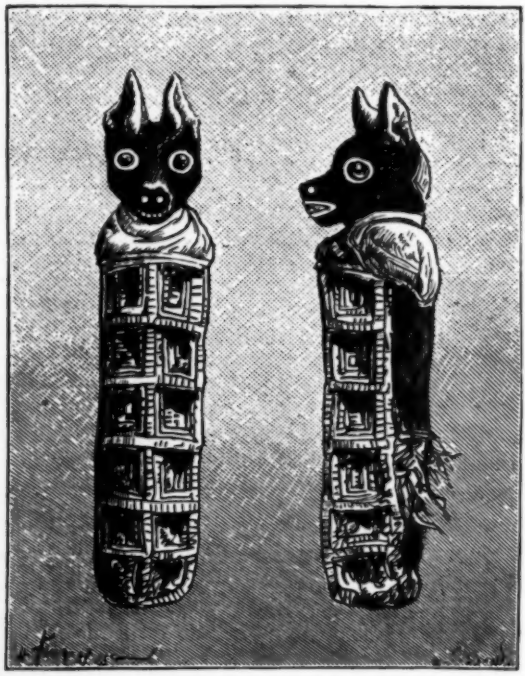


FIG. 4.—EGYPTIAN MUMMY OF A DOG WITH PASTEBOARD MASK, RECENTLY DISCOVERED BY M. BECKMANN. Front and Profile Views.

It is to be regretted that objects of this kind have been hitherto so little studied. A small number of species of dogs have been identified from the ancient paintings, but the different naturalists who have occupied themselves with researches of this sort

have not always reached the same results. The mummies would furnish them sure data, and would permit them to supplement the often deceitful evidence of the monuments. But there must not now be much delay in going into the study. European companies have been mining in the necropolises of Egyptian animals for more than twenty years. Last year a great exodus of mummified cats took place to England; and not a month passes that vessels loaded with bones and mummies of cattle, jackals, gazelles, and dogs do not sail for Trieste and other ports on the Mediterranean. When European naturalists shall at last have decided to study the mummified animals, there may not be one left in Egypt.—*Translated for the Popular Science Monthly from La Nature*

ASTRONOMICAL SOCIETIES AND AMATEUR ASTRONOMERS.

By M. L. NIESTEN.

A CURIOUS and notable fact in the history of the social condition of the present century is the disposition, amounting to a necessity, which is felt in all classes of society for organizing in groups to work in common to reach some end by the union of individual efforts which one person alone could not attain; or for forming societies. Devotees of sciences, friends of art, and patrons of letters have alike judged that, co-operating in societies, they could accomplish more and better by collecting scattered forces, and could procure in this way means for stimulating emulation and rewarding merit.

Astronomy, which has devotees and patrons in all countries, now possesses numerous societies having for their single object the progress of science, and rivaling one another in encouraging and collating the works of their neighbors, to the great advancement of knowledge of the sky.

We find the first Astronomical Society in England. Founded in 1820, it was erected into a corporation by King William IV in 1831. Sir John Herschel, son of the illustrious astronomer, undertook the preparation of the address to the friends of astronomy "It may seem strange," he said in the beginning, "that in a country like Great Britain, where science is generally carefully cultivated, and where astronomy has made great progress and drawn upon itself a large share of attention, there should exist no society occupied especially with that science; and that while chemistry, mineralogy, geology, natural history, and many other important branches of science and art are encouraged by associations which direct, by stimulating, the most energetic efforts of

individual talents, astronomy, the highest branch of human knowledge, should have remained till now deprived of that powerful assistance, and have depended for its advancement only on the isolated and independent labors of individuals. Some persons may believe that astronomy has less need of this kind of assistance than other sciences, and that in the perfection which its physical theory has reached its future progress may be safely confided to the zeal of individuals and to great national establishments devoted exclusively to celestial observations, or, at all events, to those public institutions and academies which are found in all civilized nations, the object of which is the general cultivation of physical and mathematical science. For this reason it will be necessary to make known the useful objects that may be accomplished and the obstacles that may be avoided by a society devoted solely to the encouragement and advancement of astronomy."

The society organized a minute and systematic examination of the sky, dividing it into zones of moderate extent among members who had leisure and would be disposed to give particular and constant attention to those parts, in order to determine the positions and, if possible, the proper motions of all the objects, large and small, which might present themselves within their respective limits, and keep them constantly under review in such a way that not one new celestial body of cometary or planetary nature, passing their regions, should be able to escape them. The object which the new society proposed to itself was to a large extent obtained, and the progress which has been realized in astronomy during this century is intimately connected with its history. The *desiderata* which it indicated and to which it directed attention have been supplied; and while it has not taken a direct part in all the labors that have been performed, it has rendered a great service in making them known and in promulgating discoveries. There are now in England thirty-four public and private observatories. Most of these establishments have been created since 1820, under the beneficent influence of the Astronomical Society; and this is not one of the least services that it has rendered. In forming a center accessible to professional astronomers and amateurs alike, to higher minds and more modest ones, the Astronomical Society of London was the first in developing the taste for the science to the degree to which it has grown at the present day.*

The example set by the Astronomical Society of London was followed by Germany. In 1863 there was formed at Leipsic the

* The society includes now more than seven hundred members. It has published forty-nine quarto volumes of memoirs, and fifty octavo volumes of monthly notices. These two collections form one of the richest and most precious astronomical repertories.

Astronomische Gesellschaft, which, although less important than the elder society, has organized and brought to a successful conclusion some important astronomical labors. It has an international character; and one of its principal aims is to establish among the astronomers of all countries, by meetings every two years in some city of Europe, bonds of friendship and scientific confraternity.

In the General List of Observatories and Astronomers, of Astronomical Societies and Reviews,* of which M. Lancaster has just published a third edition, a special chapter is given to Astronomical Societies. We extract from it the facts that follow relative to the foundation and organization of societies created in later years. A society was founded at Chicago in 1862 for the purpose of furnishing the observatory—by the purchase of instruments, the payment of honorariums to astronomers, etc.—with the means of carrying on its work. Associations of spectroscopists and observers of luminous meteors were formed in Italy in 1871, for the publication of special works. A society was founded in Liverpool in 1882, the principal object of which was to cultivate the taste of amateurs for astronomical observations. A special amateur directs the observatory of the society, and verifies by its instruments the observations made by the members, assists his colleagues in their researches, and carries on special work in the name of the society. The American Astronomical Society was founded in 1887, and the Astronomical Society of the Pacific in 1889. The latter society, at the end of the first eighteen months of its existence, had three hundred members and possessed two funds; one for a medal to be awarded to discoverers of new comets, and another for the purchase of an astronomical library. Popular scientific societies have been formed in France since 1864, at Paris, Argentan, Marseilles, Lyons, Nantes, and Narbonne—to which each member brings his quota of work and intelligence. The Astronomical Society of Paris has been able, through the popularizing talent and indefatigable zeal of its director, M. J. Vinot, to create two hundred and one minor observatories, and to establish a circulating library of more than four thousand volumes.

The Astronomical Society of France, which hopes to rival the great societies of England and America, was founded under the

* Liste générale des observatoires et des astronomes, des sociétés et des revues astronomiques, preparée par A. Lancaster, bibliothécaire de l'observatoire royal de Bruxelles. This collection, the several editions of which demonstrate its success and usefulness, includes a list of official and private observatories; astronomical societies; various institutions; astronomical reviews and journals; an alphabetical list, with addresses, of independent and amateur astronomers; and makers of instruments. Published by F. Hayez, printer to the Royal Academy, rue de Louvain 108, Bruxelles.

energetic impulsion of M. Flammarion. Its aim is "to bring together persons who are practically or theoretically occupied with astronomy, or who are interested in the development of that science, and the extension of its influence for the enlightenment of minds." It has now about three hundred members. The Urania Society, recently formed in Berlin, has been able by the generosity of its founders to erect a building to the purposes of Astronomy, and furnish it with the most perfect instruments. Societies of amateurs for the popularization of physical and astronomical science have been founded in Spain and Colombia, and at Nijni-Novgorod in Russia. Astronomy is no longer, in our time, the property of a few privileged persons. The public, in the whole world, has been set in the current with the facts of science by the diffusion of books written by such able popularizers as Flammarion, Guillemin, Vinot, Figuier, De Parville, and others, in France; Proctor, Ledger, and Miss Clarke, in England; and Meyer, Klein, and Wolf, in Germany; and by the announcement and familiar explanation of phenomena. At this moment, without taking account of popular scientific journals and English and American magazines, that make known the principal astronomical facts, there are twenty-nine special reviews and journals teaching astronomy to the public. There are five in Germany; six in the United States and England; four in France; and others in Belgium, Russia, Switzerland, Portugal, and Brazil.

The number of amateur astronomers is considerable, and it is safe to say that of all the sciences this is the one that can boast the most adepts among private persons. Among 1,160 astronomers now living, whose works have gained a footing in science, about half are amateurs with private observatories. In England, including official establishments and those attached to the universities, there are 34 observatories; in America, more than 80; in France, 17; in Austria, 24; in Italy, 21; in Russia, 15; and in Belgium, 5. We may say that an amateur, armed with a telescope, is to be found at every point on our planet, ready to observe a celestial phenomenon. In Chili, Honduras, Peru, New Zealand, Tunisia, and Tasmania we can meet astronomical amateurs provided with instruments, who devote their night hours to contemplating the beauties of the starry vault and to collecting observations which shall be useful for the advancement of science.

Most of the discoveries of comets, small planets, variable stars, and star-clusters are the fruit of individual researches. Were not all those amateur astronomers who, in the first ages of history, in Chaldea and Egypt, China and Mexico, drew from Nature the first explanations of celestial phenomena? From the beginning of historic time down to near our period, astronomical sci-

ence has advanced only by the labors of philosophers, who pursued it as a matter of taste and not officially. Was it not as an amateur that the canon Copernicus discovered the true system of the world? As an amateur on his little estate at Woolstrop the thinker Newton discovered universal gravitation. Cavendish, who first weighed the earth, was an amateur. Belonging to a noble and wealthy English family, he devoted his whole life to the advancement of science. He was, said Biot, the wealthiest of the learned, and probably also the most learned of the rich.

Are those not also amateurs who have made the most advance in the study of the moon? Hevelius, a counselor of Dantsic, who first undertook to define the form and position of the lunar spots? To whom do we owe the details of lunar topography? To enthusiastic amateurs in astronomy—Schroeter and Lohrman in Germany, and the machinist Nasmyth in England. And now we can count by the hundred the men who give their time to observing our satellite in all its details; and a new fact is added every day to those which we already know.

The knowledge which we possess of the spots and faculæ of the sun is also derived from materials collected by amateur astronomers. We cite first Fabricius, who, living at the beginning of the seventeenth century, first observed the spots and ascertained the period of solar rotation. An amateur, also, Schwabe, of Dessau, discovered the periodicity of the solar spots, and Carrington, Warren, and De la Rue made their admirable studies on the central star of our system. Janssen found a way to observe the protuberances without being obliged to wait for the rare and brief instants of total eclipses; the musician, William Herschel, extended the frontiers of the solar republic, and radically transformed sidereal astronomy; the mathematician, Le Verrier, then a stranger to the Observatory of Paris, discovered Neptune in the depths of space, a milliard of leagues from here; and Dambouski, Burnham, and Gledhill, skilled observers of double stars, have measured the couples that move in remote parts of the sky.

We could not, if we should try, cite the names of all the amateurs who have discovered comets. It was an amateur in astronomy, Flangergues, of Viviers, who first observed the celebrated comet of 1811, the length and brightness of whose tail were the wonder of our ancestors. At seventy-one years of age this indefatigable amateur of astronomical science was so happy as to discover a second comet. Among comet-hunters, we should not forget Pons, porter of the Observatory of Marseilles, who had in France no rival as a discoverer of comets except Mersier, Director of the Observatory of Paris, whom Louis XV surnamed the "comet ferret."

Besides their activity as discoverers, amateurs have also done

service to astronomical science as calculators. What a number of names we might cite of those who have given their time to the collection of observations and determining the courses which comets and the minor planets describe in space! The positions of three hundred thousand stars are now known; one third of the work of determining them has been done by volunteer astronomers. The famous catalogues of stars to which we have recourse in official observatories have been prepared in the private observatories of Wrottesley, Hartnup, and Groombridge. To produce such results, how great must have been the zeal and devotion of those amateurs who, after numerous years of watching, have been able to get together thousands of observations, with no reward except the personal satisfaction of having been serviceable to astronomy! Such labors, which are of the most ungrateful kind, and to which professional astronomers devote themselves, have no immediate result. The glory and fame which the discovery of a comet or a planet brings at once to its author are not to be found in them. They serve for the preparation of material which it is certain can not be productive for ages to come; for it is only then that these catalogues can help establish by comparison with new catalogues minute displacements of stars on the celestial vault, and can furnish the means of calculating the proper motions of these stars, and consequently of determining the direction and velocity of the movement of our solar system in space.

We need not go further in the enumeration of the various lines of progress and the discoveries that are due to private persons. We can appreciate to a certain degree the extent of the services rendered by them when we see the strongest astronomical society, that of London, distributing in fifty years more than a third of its annual medals to amateur astronomers.

Other laborers than astronomers have assisted in the advance of the science by furnishing amateurs easier means of examining the sky and bringing the greatest exactness into their observations. Among them are such men as Molyneux, Dent, Grubb, Alvan Clark, Secretan, and the clockmakers, machinists, and opticians who have placed their constructive talent at the service of astronomy. We should not forget to pay our tribute of admiration to the Dudleys, Licks, and Bishoffsheims, who have disinterestedly employed their large fortunes in constructing and furnishing observatories, and providing means to assure their existence in the future.

What emulation prevails among amateurs in astronomy! They pride themselves on cultivating the science as independent men, and spare neither time nor pains to secure a place in the legion which enrolls Copernicus and Herschel in its ranks. One can, indeed, engage with profit in those beautiful studies without

making it his real profession, for means for sounding the celestial spaces are now within the reach of nearly every one. You may ask what pleasure there is in being an amateur in astronomy. I answer, Try it, and, when you have once tasted of the tree of science, you will never be able to leave it. Day and night the observer will always find subjects to study in the sky. In the daytime, the sun, its apparent motion, its dimensions, the spots on its disk indicating convulsions in its luminous atmosphere, eclipses, transits of the inferior planets, and the mysterious spectroscopic revelations of solar light offer themselves as subjects for investigation of the highest importance and the greatest interest. The hours of the night are preferred by the astronomer for his work; and he then gives himself up to his favorite occupation while others are taking their rest. A dark veil is spread over everything of active life; but above, in the sky, the curtain has risen, and a magnificient spectacle awaits the astronomer. Those thousands of stars which Newton and Galileo and Kepler and Copernicus and Ptolemy and Hipparchus contemplated, show themselves now in all their glory; they are resplendent with light, and remind us of the glory of those who discovered them or who have studied their motions. The astronomer, in view of this incomparable spectacle, is affected by a profound emotion, and feels himself growing larger before those mysteries which he has been able to sound, and he rises from his contemplation with invigorated mind.

All has changed on the earth, he says, but the sky is still the same. The plow has passed over powerful cities, extensive territories, once teeming with life and occupied by mighty nations, and the languages they spoke have been forgotten, but the stars that shone in their eyes shine for us, and the same eclipses recur, invariable in their unchanging cycles; those people observed them, and we are observing them in our turn; the same equinoxes bring the spring flowers into bloom, and the same solstices mature the harvests. The sun, moon, planets, satellites, constellations, stars, and milky way are there now as they were centuries ago, revealing their majestic beauty to the observer, and raising fold by fold the veils with which Nature has enveloped their mysteries.

Astronomy formerly held a much larger place than it does today in the attention of the people. In fact, as Houzeau has well said, our peoples have no idea of the necessity the men of the beginnings of history were under of referring constantly to the celestial movements. We are in the midst of so numerous clocks that no one need be ignorant of the time of day, and they are so well regulated by the aid of the meridian glasses of observatories that the masses hardly know that they require attention. Our

weeks, months, and years are fixed invariably for us by the calendar; the rising and setting of the great lights, the phases of the moon, and even eclipses are in a certain way in everybody's hands, and the whole general movement of the stars is simplified for us. Ships arrive at their destination without having deviated from their route, and that by means of celestial observations so rapidly taken that the passenger hardly remarks them. All these operations, now become so simple, and of which the common man is unaware because they are made apart from him, were formerly the charge of every one. Before there were clocks to keep the hour and show it continuously, every person had to determine it every time he wanted to know it. Instead of taking the time of year from the almanac, he had to read it in the sky, the changes of which he was obliged to follow. In journeys, whether across inhabited countries or on the sea, only a few of the company could give an account of the road they had passed over or could decide upon that which should be followed. None of the professional services now placed in the hands of a few specialists existed then; every man, on the contrary, at every moment, had to be his own astronomer.

If necessity no longer provokes continuous astronomical studies and observations, and the astronomer has no reward but the pure pleasure that science gives, how comes it that astronomy, more than any other science, has created so many adepts? We will attempt to explain it. Astronomy, beyond every other science, offers phenomena which, while they are within the domain of the highest researches of philosophy, can both arrest the attention of persons having some scientific ideas and excite the curiosity of little-instructed observers. Chemistry, in its investigation of the constituent elements of the universe; physiology, in its delicate researches in the secrets of animal life; the transcendent logic of geometry enthusiastic over a formula that deters those who are not initiated—pass the comprehension of the vulgar. But the glories of the rising and setting sun, the serene majesty of the moon when it crosses the celestial vault, the mild luster of Venus, the splendor of the firmament on a cloudless night, the appearance of a comet with its long tail floating in the skies like a resplendent banner, are spectacles that can charm both the philosopher and the peasant, the mathematician who measures worlds and traces their routes, and the shepherd who sees only their figures. Further, if the object of all science is to enlarge and purify thought, to fill the mind with noble contemplations and give it a calm quiet, astronomy, from this point of view, is superior to all other sciences. No other science includes in itself so manifestly the abstractions that form the basis of our intelligence and so grand ideas of time, space, number, motion, and force.

The durations of the movements of the planets are immense. The variations presented in the periods of the stars occur by thousands of centuries. It takes light millions of years to cross the distances that separate the stars from one another. What can be said of the immensity of those worlds as compared with which the earth is but an atom, of the prodigious multitude of the suns of space, more numerous than the grains of sand at the bottom of the sea, and of those velocities with which all the stars are carried in immense whirls across the infinite ?

But you tell me astronomy is a perfect science; it has reached the height of knowledge, and there is nothing left in it for the amateur. I answer that there is always something to be reaped in the astronomical field of investigation for both the learned and the modest amateur. How many times has it not been said that all was known; and then, as the power of modern instruments was increased and new methods of investigation were invented, new conquests were made in the sidereal domain! Galileo's telescope had immense treasures to look for in the sky. In this age the improvements in the telescope have made known Uranus and Neptune and more than three hundred minor planets, with, a few years ago, the two satellites of Mars. Numerous comets and hundreds of smaller nebulæ discovered every year give additional proof that a harvest is always awaiting reapers in the sky. When we consider the immensity of the universe, how could it be otherwise ?

Analogy teaches us that the sun is one of the innumerable stars that spangle the firmament with their lights, and that each star is the center of a system like that to which we belong, and of which the sun is the center. Of all these suns, centers of planetary systems, only a few thousand are visible to the naked eye, while telescopes reveal millions of them. Then, if we consider the nebulæ—those little milky spots scattered in all the zones of the sky—if we remark that nearly all of them can, by the aid of strong optical powers, be resolved into thousands of luminous points, and that consequently they are presented to our eyes as immense milky ways investing distant universes, we arrive at the astounding conclusion that little vaporous nothings, which we can hardly distinguish with our strongest instruments, form, not a universe like our solar system, but that each of them is an agglomeration of myriads of universes, the extent and number of which can not be imagined.—*Translated for The Popular Science Monthly from Ciel et Terre.*

THE SPINNING SISTERHOOD.

By OLIVE THORNE MILLER.

NO fairy of the old tales ever conferred upon her favorite magic gifts more potent than a weapon whose slightest touch is death, and a thread becoming as needed a ladder to scale a wall, a balloon to navigate the air, a net to supply food, and a tent or a nursery for its possessor. Yet these are the common endowments of a whole family of fellow-creatures whom we —we despise.

No being that lives is more universally detested, more remorselessly destroyed, than one who exists only to serve us, whose whole life is undying war upon our most powerful enemies. Well indeed is it for us that she possesses the two magical gifts, and that, do our worst in our blind and stupid way, we can not exterminate the race—the industrious, the patient, the silent "daughter of Arachne"—the spider. Mysterious and solitary being, dumb, probably deaf, of strong though not varied emotions, with enemies countless as the leaves of the forest, who shall penetrate the secret of her life?

Is it not enough that every bird that flies, ruthlessly robs her nursery, devours her babies, and even snatches her own soft body from the very sanctum of home; that gauzy flies steal their greedy young into her nursery to fatten upon her infants; that to monkeys, squirrels, and lizards her plump body is a sweet morsel they never resist; that frogs and toads snap her up without ceremony; that centipeds seize her in resistless grasp; that wasps paralyze and bury her alive? Are not these enough, without man joining the hosts of exterminators? Man, too—in whose service she lives!

Consider for a moment her usefulness. Count, if you can, the thousands of flies and mosquitoes eaten by one common house or garden spider in a summer. Then remember her harmlessness. Other servants we must pay: birds eat our cut-worms, our caterpillars, and our potato-beetles, but we have to pay a tax—small, it is true—in fruits, in berries, in green peas, in corn; owls and hawks, while they destroy moles and mice, indulge now and then in young chickens. But the daughter of Arachne asks no reward, neither fruit nor vegetable suffers from her touch, no humming or buzzing attends her movements. Steadily, faithfully she goes on her way doing her appointed work; and we, so wise, so far above her in the scale of being, we—murder her!

Not content with that, we call her "horrid," while in truth she is a beauty, if we only had eyes to see. The largest of the family, the *Mygales*, clothed in furs, and always spoken of as "monsters,"

even by men of science mentioned with insulting and repulsive epithets, are seen under the microscope to be really beautiful, with every hair a plume, and the clustered eyes a crown of brilliant gems.

The most congenial home of the spider is naturally in the paradise of the insect. In the Amazonian forest with its hundreds of species, ranging from the almost invisible atom that sails off on its own magic thread, to the bird-killer with eight-inch spread of legs, we of the Western world must seek our most marked specimens. One of the silent family described by a traveler has a body like frosted silver studded with gold and emeralds, legs resembling gold wire, and a net of exquisite gold-lustered silk. Brilliant red, glowing orange, velvety black, glistening white, and other colors in combination, both charming and grotesque, distinguish some of them, while others appear in disguise. Withered blossoms, growing leaf-buds, thorns, rusty pins, sticks, bits of bark, and balls of their own silk are successfully counterfeited by one and another of this wonderful family. Many of these interesting Brazilians are unwelcome to the throat of bird and beast, by reason of spines, knobs, and excrescences of the most unique and fantastic sort. In that land of extremes also is found their most remarkable work, webs covering the whole top of a tree, with broad ribbons to hold it in place; and others so strong as not to be broken by small fruits thrown violently against them.

Intelligent, too, is our little arachnid—cunning she has been called. Many instances could be given; one of the most interesting is Belt's account of the behavior of spiders in the presence of the terrible eciton ants, which sweep the country in vast armies, and devour every living thing: "All insects and small animals recognize their relentless foe and make frantic efforts to escape. The spider alone yields not to panic, but uses common sense—may not one say reason? Some that were observed, upon the first scent of danger, took to their long legs, and having two more of them than any insect, and no inclination to stop for luncheon, soon put a long distance between themselves and the savage little hosts. Others, not caring to run, neither to be eaten, simply swung themselves out into the universe by their magic thread, and there hung between heaven and earth, like a certain legendary coffin, till the uncivil enemy had passed by. Not one was so stupid as the insects, to hide and be in a moment dragged out by the murderers whom nothing escaped. Perhaps the coolest personage on the scene was a harvestman or Daddy-long-legs, who stood on the ground right among those thirsting for the drop of blood in his round dot of a body. His legs were long, and he had eight of them, as well as a head (though one could hardly say on his shoulders). There he stood, calmly lifting up leg after leg,

as an ant approached it, keeping a very sharp eye out, and never allowing one of the enemy to get near enough to touch him. Sometimes he had five legs in the air, and, if an ant came near one of the three on which he rested, he could always find space to put down one of the others to complete his tripod, while he lifted the threatened one high above the head of his tormentor—a wonderful exhibition of intelligence as well as presence of mind."

Passing under a tree on some bright morning in summer, one may chance to come upon three tiny balls on a thread of silk. They are as alike as beads on a string, and seem to be bits of rubbish wound with silk; but, like the balls of "my uncle," they are a trap for the unwary. Examine them. The upper one, easiest to reach, *is* the bundle of rubbish it looks to be; the lower one, also convenient to reach, is the same; but, touch the middle one, and out shall rush its owner, indignantly demanding by every movement what you mean by disturbing her. It is her castle, and behind its hinged door she lies in wait for the minute creatures that she eats, while enemies that would devour her on sight pass her ingenious home without suspicion.

A still more curious maker of balls "with intent to deceive" lives in New Jersey, and has been described by Mrs. Mary Treat. She constructs her balls of loose masses of her own silk, covered with bits of rubbish, even the cast-off garments of the insects she has eaten cut into atoms and scattered over them. Of these images she prepares several, fastened in a line through the web, with a vacancy for herself. The color is gray and white, and so closely do the balls resemble her that when she takes her place among them one can hardly tell which is spider and which imitation. What is strange, and proves all this to be an intentional disguise for herself, the balls are always of her own size; when she is small they are so, and as she grows she adds to her "doubles." The same policy protects her cocoons, strung along beside the queer, spider-like objects. It requires the sharp eyes of a naturalist to detect them.

If the spider is a good hater, none the less is she a warm friend. She is quite willing to be friendly with man, and many accounts are on record of her pleasant relations with prisoners. In this close acquaintance her individuality and character come out. A story is told of one who appeared to be wanting in a sense of humor (as others of her sex are said to be). She did not relish a joke, and peremptorily declined to be made game of. The relater had cultivated her friendship so successfully that she readily came to him and took flies from his hand. After some weeks of this amicable understanding he began to tease her. He offered a fly as usual, and, when his small friend came confidently forward to take it, he snatched it away. The first time she evidently thought it an acci-

dent, for, on seeing it held out again, she tried once more to take it. This time her tormentor let her get hold, and then drew it away. Even this she forgave, doubtless finding it hard to believe that her friend had become her enemy. But when he tried it a third time, the "last link was broken," the friendship at an end. She could not trust him, and the most tempting fly and the loudest buzzing appealed to her in vain. She refused to go near it, and in a day or two she deliberately abandoned her home and departed for parts unknown, probably soured for life.

Curious and unexpected traits of character were shown in captivity by two of the *Lycosas*, or running spiders, among whom—according to popular notions—are some of the most terrible of the race. The account appeared in a scientific magazine some time ago. The first member of the happy family was living contentedly in a large cigar-box with a cover of glass, accepting gratefully the fare provided, and becoming quite tame, when a second one was captured and placed in the same box, and the owner sat down to see one eat the other, the legitimate result, as he supposed, of his act. Nothing of the sort happened; on the contrary, the two seemed shy of making acquaintance. For two or three days each spider stayed on her own side of the box and made no advances, either of war or friendship, but in a week their reserve wore off and they became the best of friends. Together they ran when a fly was offered, side by side they drank from the little pool of water provided for them, and each amiably waited her turn to drink when water was given in a brush. Under this delightful and unheard-of state of things, having plenty of food and none of the work that makes the life of freedom a stern reality, they actually grew frolicsome. They chased each other around the box, playfully as two kittens; they retired to opposite corners, and then ran at each other with mouths open as if about to clinch for a fight, which the observer confidently expected to see. But on meeting each rose, stood erect on her hind feet, and laid her fore feet gently upon the head and body of her friend. Then, just as the astonished spectator looked to see them start off in a waltz, they dropped to their eight feet, ran back to their corners, and repeated the queer performance. This was a favorite amusement, with which they varied the semi-serious business of hunting flies within their small domain. They were exceedingly neat in their toilet, and after each meal every part of the body and legs was rubbed and brushed, in systematic order, and the minute heap of dust resulting carefully thrown away.

It may be thought that their refusal to justify the popular notion, and eat or be eaten, was because of their equal size or their close relationship. To test this, their keeper introduced within their box a common house spider, much smaller in size,

expecting to see the vaunted bloodthirstiness which should end in the death of the intruder. How did the friends behave? They simply avoided her, as one whose ways were unfamiliar. And the stranger—did she cower in fear, or show fight? Neither. Finding herself at liberty and comfortable, she proceeded at once to business, and, when the owner of the menagerie came back after several hours, he found the new-comer had nearly filled the box with her web, while the rightful owners thereof were crowded into a corner, meekly submitting to her usurpation of their quarters.

Babyhood is almost unknown in the spider world, or at least there is very little of the helplessness of most young creatures. It is hard indeed to believe the terrible tales told by Prof. Wilder of the life that goes on in the family before the nursery doors are opened. He affirms that the cocoon of *Epeira riparia* contains hundreds, perhaps thousands of eggs, and that the doors of the silken tent are not opened for some weeks after hatching, which is a time of fearful orgies, brother and sister devouring each other, without fighting it is true, but none the less relentlessly enacting the tragedy of the "survival of the fittest." The professor thinks he is justified in his conclusions, but we can afford to wait for further proof, and not believe it until we must.

The young arachnid, whatever her cocoon experiences, comes out of that snug home with all her wits about her, and is a very knowing baby indeed. The young trap-door spider very early in life, having attained the size of a large pin's head, makes for herself in the ground a silk-lined residence, and defends it against friend and foe. The common house spider no sooner leaves the home nest than she

> "takes
> Her silken ladders out and makes
> No halt, no secret, scaling where
> She likes, and weaving scaffolds there."

The garden spider, too, begins life for herself very early, spinning a web as big as a silver quarter, and as pretty as her mamma's.

The crowning glory of this queen of spinners and weavers is her motherhood. Never was a mother more devoted. In spite of the fact that her family numbers anywhere from one to ten hundred, she wraps the eggs snugly in silk, and carries them everywhere she goes, or carefully secretes them; and she defends them with her life. Not one, from the least to the greatest, abandons the helpless infants to an ignorant nurse to be pinched or petted according to the humor of that functionary—not one!

When the babies outgrow the nursery, she opens the door and sometimes takes them all on her back, though they cover her like a blanket. Then she feeds them, either with ants or flies, which

she crushes and holds while they crowd around and take lessons in what is to be their life business.

In a pleasant home in New Jersey, already mentioned, have been made some most interesting observations in spider ways by Mrs. Mary Treat. Her studies were mostly among the tarantulas, whose habit is to excavate underground residences, and to Mrs. Treat belongs the honor of discovering two new species. First is the tiger tarantula, named from the tigerish stripes of the legs, who lives in a burrow several inches deep, with a mysterious private room at the entrance, and a door skillfully designed, and covered with rubbish to look like the ground about it.

Of this family, Mrs. Treat had about thirty under observation when August came, and with it the spider's worst foe—the digger wasp. In her book Home Studies in Nature, is an exceedingly interesting account of the precautions of the wary spider and the persistence of the wasp.

Most of the spiders, wise enough to know their conqueror when they saw her, hermetically closed their doors when the raid began, and tried to remain behind their bolts and bars until the danger was over; but as it was two or three weeks before all the wasp babies were provided for, many a venturesome hermit grew hungry, opened the door a-crack, and cautiously peeped out. Alas! the caution was too late. So lively and so sharp in the hunt was the enemy, that scarcely one of these imprudent ones escaped the terrible fate of burial alive. Out of all Mrs. Treat's family only five remained to open their doors and enjoy life after the wasp war was over. This is entirely the rage of motherhood. At no other time in the year does the wasp molest the spider.

This tiger spider, in spite of her formidable name, is an exception to the customs of the family, in having a spouse as big as herself, who constructs a home, and lives as comfortably as she. In general the female spider only is a respectable member of society, the male being often a vagrant and living no one knows how, besides being undoubtedly the original of the "little husband no bigger than my thumb" in the old nursery rhyme.

The tarantula family, to which belong our New Jersey friends, is the most celebrated as well as the most maligned of the race, although most of the stories have been proved to be myths, and their accomplishments in the building line have brought them into favorable notice. America has its own specimens of the tarantula, one of which, perhaps the largest yet discovered, was found in South Carolina by Prof. Holmes, on his own plantation, and was sent with nest and young to the Museum of Natural History in Central Park, New York. This truly fearful arachnid had a body larger than a mouse and covered with hair, as well as

the legs, which were short and stout. The nest was so firmly made that, although underground, it was easily lifted out of its place without injury. Indeed, it was no mere silk-lined hole in the ground; it was a regularly built house of clay packed into a tight wall, and hung with curtain of silk. At the bottom of this model residence was a small opening for a waste-pipe, so that no rain should drown the builder within her own doors.

The tarantula of the Pacific slope is of note particularly on account of her enemy, the tarantula hawk, or tarantula-killer. The spider is of large size and no coward. If a stick is poked at her, she does not run; on the contrary, she starts up that stick so promptly that no one less nimble will stay to interview her. The wasp that makes her life a burden is nearly two inches long, with brilliant blue body and orange wings. Like the more humble resident of New Jersey, her sting produces paralysis, and, when she has prepared the burrow in which to deposit the hopes of her family, she invariably starts out after a tarantula to furnish a supply of food for the egg she buries with it. Spiders have been found in this remarkable half-dead state several years after they were buried, still limber and apparently healthy.

Dr Horn, of Philadelphia, describes particularly this strange contest with the wasp. The insect flies round and round in gradually decreasing circles, while the spider stands half erect on her hind legs. Seizing the first favorable chance, the wasp dashes in and delivers a sting, instantly flying away and resuming the circle flight, till she sees another opportunity to strike. Two or three touches are usually enough to subdue the most savage tarantula. But the trouble is often not over for the plucky wasp even then. The battle may be without sound, but it is not without scent. The use of her sting is accompanied by an odor which is quickly recognized by any other wasp-mother in search of a spider. If one chances to strike it, she follows it up on the instant, and, if the spider is not underground, makes a fight for it. So furious is the battle that sometimes both of the combatants are killed.

In the West Indies the trap-door spider is appreciated and respected as a useful servant for its work in killing cockroaches, which, unless checked, would destroy their houses. It is bought, carried to the house, and cherished as we cherish a cat.

Quite the most interesting of this family is the second discovery of Mrs. Treat, which she called at first *Tarantula turricula*, or turret-building tarantula. Should one in his walks chance to notice a tiny five-sided tower rising out of the ground, elegantly made, of sticks crossed regularly at the corners in log-cabin style, and sometimes decorated with bits of moss, he would never guess that a spider was the architect. Yet such is the work of Mrs.

Treat's turret-builder, and she has not only watched the process, but has taken part in it herself.

The pentagonal structure is not the home, it is but the entrance and the watch-tower on top of which the owner delights to sit and make observation of the world about her, with sharp eye to the insect supply. The real home is a burrow several inches deep. The building of the tower is most interesting, the sticks being carefully selected, fastened in place by threads of silk, and each layer covered by a close row of small balls of earth brought up from the bottom of the cave. These balls are laid on the row of sticks, pressed flat and drawn down so as to coat the inside, and when finished, therefore, the tube is smoothly plastered. Then the silken hangings are added, and her home is complete. The towers are two and a half inches high, and are strong enough to be handled.

One builder, who allowed Mrs. Treat to assist by furnishing material, proved herself to be not only very hard to suit, but to have a temper of her own, rejecting sticks that did not please her by flinging them far off, exactly as she habitually disposed of the remains of her meals. This spider, too, lived in harmony with her mate, even in so small quarters as a glass jar. But she had her own residence, into which Mr. Tarantula Turricula might look, but was far too wise to enter. Her motherly cares and anxieties were absorbing in the extreme. The bag of eggs, large as a hazel-nut, was constantly carried about, and placed where it was warmest, in the sunshine, toward the stove, or wherever the heat was. This untiring devotion continued for two months, and when the young were out she took them all on her back.

This close student of spider ways could find no inclination in the baby to kill, much less to eat, one of its own family. She tried them with a freshly killed specimen, but the young would not notice it; and when mamma saw it she examined it carefully, then flung it away with other rubbish. She fed the youngsters by crushing a fly for them.

The most serious charge brought against our little friend is of cruelty to her kind, and especially to her spouse. It would not be surprising if a creature made and equipped for the duty of insect-hunter, and to that end filled with the "rage of killing," should now and then fail to distinguish between friend and foe; but as a matter of fact, though some species may justly be accused of coolness toward their mates, others, on the contrary, live in peace with them. It must be remembered, too, that the female spider is always under the spell of her double duty, to reduce the insects and to preserve the race. As to their relations with others, though in general spider life is solitary, there are instances of gregarious living, as well as of small spiders being not unwelcome

guests in the web of larger ones. The general charge of cruelty may have arisen from the conduct of some of the *Epeira* family, one of the largest and gayest in dress, as well as the most common and widely distributed of the spider tribes.

A noteworthy member of this family found by the naturalist in the Challenger Expedition (*E. clavipes*) makes a web so strong that even birds are made prisoners by it, though whether the spider devours them does not appear. On the same expedition another was observed which possessed a more imposing residence, having by way of an upper story a globular mass of irregular threads over her horizontal "first floor." In this attic lived her spouse, a minute creature after the spider fashion of mates. Between his quarters and the parlor, where madam herself, the builder and provider, had her place, hung suspended the precious egg-bags, or nurseries, three or four in number, of different ages.

The cunning—not to say the intelligence—of the race, is shown by some in their unique method of concealing themselves from a known or suspected enemy, while remaining in plain sight all the time. It is by a violent shaking of the web, which, being extremely elastic, vibrates so rapidly as to confuse the outlines of the substantial body standing in the center and causing all the commotion. Could she have invented a more ingenious way if she had been a learned scientist?

The mania for decoration has reached, or possibly it began with, the spinning sisterhood. Dr. McCook describes some curious examples. There is the bank *Argiope*, a personage in silver drab, who makes for her own special use a white silken carpet in the middle of her large round web. From the top of the carpet reaches a ribbon of the same, and from the bottom descends a zigzag cord like the famous "winding stair" of the old song. Resting, head down, in her place, she is able to defy ordinary enemies, for she knows the trick of shaking her web until her body is absolutely invisible. Unlike many of the family, she prepares her nursery out of the house, forming a tent by lashing leaves or grasses together, and fastening securely within it a pear-shaped cocoon. This cradle, which is to swing in its airy tent all winter, is glazed outside, but within a mass of soft, silken blankets which wrap the eggs from all harm.

A near relation of this prudent mother, the banded *Argiope*, in white furry coat, decorates her symmetrical web from top to bottom with ladders of white silk. Decoration reaches its lowest form in a web described by the same observer, where the cocoons, the precious cradles of the household, are covered with cast-off shells and gauzy wings left from past and gone feasts—whether as "souvenirs" of the occasions, or to disguise the true character

of the cocoon, we can only guess, for we have not got at her opinions as yet.

Perhaps the most peculiar of the web-makers is figured by Prof. Wilder, who calls the wise little spinner the triangle spider, from the shape of her snare. From the point on a twig which she selects for her resting-place, or roost, as the professor calls it, she stretches a single line a few inches, and from that point spreads four long, widely diverging lines like radii. Having done this, she proceeds to cross these cables with viscid threads like the rounds of a ladder, and, when completed about two thirds the length of the radii, the whole web looks like three distinct ladders, side by side. Everything arranged to her mind, the small architect retires to her post, the single thread from which the whole hangs, and sets her trap by drawing up the slack and holding it in a loop between her feet. In this strained position she remains for hours with the motionless patience of her race. But let a fly touch her web and she is wide awake on the instant. Her trick then is to let the loop she has held go with a snap that jerks the web and is sure to still further complicate the entanglement of the struggling fly. If this is not enough to complete his capture, she repeats the operation several times. Should he not be by this time altogether subdued, she starts down her line, drawing a fresh thread after her, cutting the old ones one after another, and, at last, as the professor says, she gathers the entire net in her hands, and throws it like a blanket over the prey. If this skillful little trapper were not a poor little half-inch-long spider, what a wonderful performance that would seem!

The triangle spider too is more amiable than some of her family in giving her mate a share of her home. According to our close observer of New Jersey, the little creature, about half the size of his spouse, lives in an upper corner of her web, apparently interested in the fly-catching business merely as a spectator. Whether he ever makes a web, and where he gets his dinners, are still unknown.

Many attempts have been made to compel the "daughter of Arachne" to work in harness, so to speak, and in consideration of food and protection to give up her silken threads for our use, as the silkworm contentedly does. Fortunately for her liberty, she is a personage of so marked individuality that no way has yet been devised competent to overcome her natural inclination to have her own way. Prof. Wilder has given much study to the subject of ways and means, and has, he thinks, perfected a plan by which one of the strong-web spinners (*Nephila plumipes*) may be trained to weave as well as to eat in our service. By this plan each spinner is to have her own home, a wire ring surrounded by water. She is to be fed with flies, which, alas! are not to reduce

the hosts of the air, but to be bred for her, and every day she is to be placed in the stocks and compelled to give up her silk. This plan may possibly be feasible, but the space and the labor required would make the silk so costly that it could not compete with the product of the contented and simple-minded silkworm.

In fact, the spider, like the cat, is a self-reliant being, who will submit to petting, will become perfectly tame, so long as the friendship is reciprocal, but will never be made a slave to serve our whims. Her sturdy independence, her ability to take care of herself and to go where she pleases, were long ago recognized; for doth not the wise man of old say, "The spider taketh hold with her hands, and is in kings' palaces"?

HEARING IN THE LOWER ANIMALS.

By M. PIERRE BONNIER.

SLOW as we have been in recognizing that man owes the superiority of his form and his attributes to the experience of his entire animal ancestry, we have been prompt to attribute to other animals psychical and sensorial qualities more or less nearly identical with ours. There really seems to be some insolence in assuming that hearing, as we enjoy it, is refused to the immense majority of living beings, and especially to all the invertebrates. This arises partly from the fact that we are hardly acquainted with our own senses, and that many of our faculties are still left for us to discover while we use them in a way as constant as unconscious, and partly from our natural tendency to base on distant organic analogies functional assimilations which are far from being always admissible.

Here is a pigmentary spot to which we assign the dignity of the eye; there, a hair, an otocyst, which we call the auditory organ; and at the same time we assume that the spot is for seeing and the hair for hearing. As sight and hearing are known to us only as we have them, there results a deplorable misinterpretation of the sensorial function in animals.

Can we, however, have any conception of the power of smell of a ray or a rat? Are there not some insects which can supply the place of nearly all the other senses by the richness of their smell? And do we, aërial animals, know anything about the kind of sense of smell that water animals have?

The comparative physiology of the sight would show curious differences between us and any animal. Ants might have theories respecting luminous undulations that would seem very strange to us. Do they know what we understand by color? Do they com-

prehend anything but quantity and direction where we perceive light and tonality, form and perspective? Is the luminous world for them and for many other insects nothing else than a special palpitation of disturbed space which they analyze, orienting themselves in it by the perception of the force and direction of the direct or reflected disturbances? Do the handsome colors of butterflies prove that they are sensitive to the colors of flowers; and can we make sight play a certain part in the curious mimetic adaptations of different animals? Selection may serve us better than we should do ourselves without our aiding it; and it is not always by tactics that an animal escapes its enemies.

Mimicry of form and color addresses itself to the sight of the enemy, and there doubtless also exists a mimicry of odor. This, however, only proves that the enemy hears and sees without there being any calculation on the side of the interested animal. There is nothing astonishing in the thought, for we frequently meet persons to whom particular colors are unknown, and who have, therefore, only an incomplete idea of light; and if we look for sensorial memory and æsthetics behind the senses, the divergencies will be found still stronger.

Hearing, according to an opinion that appears solidly established on facts, is well developed in animals quite distant from us. Instances in point are the spider of Grétry and other spiders which seemed to have real musical tastes; eatable crustaceans, which can not be fished for successfully except in the most rigorous silence; the crabs of Minasi, which stopped in the midst of most lively frolics when a bell called them to order; the prawns of Hensen, which leaped when the slightest sound reached them; the shrimp, which exhibited in the hairs of their tails what were taken to be organs of hearing.

Dahl has ascertained similar facts concerning spiders. Romanes remarks that these insects approach instruments having a pleasant sound, and cites an observation of Reclain, who, during a concert at Leipsic, saw a spider come down a chandelier while a solo was performed on the violin, and go back very quickly as soon as the orchestra set in. He, however, expresses doubts as to the meaning of these facts; and many authors, including Lubbock and Forel, have not been able to ascertain that insects hear.

Hearing means perception of noises and sounds; and it is this perception that we refuse absolutely to every being deprived of a sacculo-cochlear apparatus. If an animal hears because certain hairs of its body are set into vibration by certain disturbances of the air, then a barley beard, a piece of velvet, and a brush vibrating harmonically, hear likewise. If we should invest the most hopelessly deaf man with a stiff-jointed armor, like the armor of the men-at-arms of the middle ages, and should put his head into

a vessel capable of vibrating and trembling, he would come to a stand at the first shock like the crabs of Minasi, or would leap like the prawns of Hensen. It is not the sound that will affect him, for he is deaf, but the trepidation, which, disagreeable to a mollusk, would be intolerable to a crustacean enveloped in rigid pieces, adjusted and in contact. Nothing is more like the noise of a fly's buzzing than the sound of a tuning-fork or of soft instruments. The same flight of a fly and its energetic efforts to free itself when captured, also produce a disturbance of the air like that of the tuning-fork; what is a humming sound to us is to the spider a beating of wings.

Romanes has cited, as apposite to this subject, an interesting observation by Boys, which is very instructive, and admits of an easier interpretation than the author seems to have believed. Boys remarked that, on lightly touching with a tuning-fork a point of a spider's web, the insect turned at once to the side of the instrument, and tried the rays of its web with its fore legs to discover what was vibrating; then, coming closer and closer, reached the instrument and tried to seize it as it would have done with a fly. We know that spiders do not enjoy a very delicate sight, and that their sense of smell is not remarkable; they are accorded, on the other hand, a very fine hearing, which serves, according to the authors, the satisfaction of their musical tastes and the gratification of their carnivorous appetites. I believe, however, that they are absolutely deaf and nearly blind, but are remarkably well endowed with what we might call a sense of trembling—a sense which suffices for the needs of the immense majority of animals, and which is complicated somewhat late among the higher animals with sonorous perceptions. Sound is, in fact, like color, of recent acquisition in the animal series; it is a thing of sensorial operations that require a remarkable degree of perfection.

We have an organ, the cochlea, which permits us to appreciate fast rhythms, under the form of sensations to which we can attribute a place in a whole of continued sensorial affections of the same character, and group them in series. The spider perceives a trembling, feels the thread that vibrates most, runs along it, stops an instant at the branchings, and arrives at the point where the force, the form of tremor characteristic of this or that prey, suggest to her the instinctive and sometimes intelligent manœuvres, as we saw in the case of the tuning-fork, which will bring that prey into her possession. The same automatism studied by Fabre is observed in the spider; and the point of departure of that series of adapted acts is always the perception of a trembling.

The center of the web, the meeting point of all the radiating threads, is a veritable center of information, and the point to

which the spider returns to get the right direction. Furthermore, the extreme delicacy of the threads, the tension of which is augmented by the weight of the spider, informs her of disturbances of distant origin, which are communicated only by the air and arrested by this light screen. Boys's spider glided along the thread toward the tuning-fork, as the spider did for Reclain's violin solo, and came back when Boys touched a point of the web with the tuning-fork. This experiment sufficiently explains the musical interest that led the Leipsic spider to the violin whose vibrations reached it. But at the first *tutti* or concerted crash the whole room trembled, including the web, and our spider ascended precipitately.

To a web-making spider, the regular trepidation or oscillatory vibration, which is sound to us, means simply a struggling prey to be taken; a spider placed upon a table approaches the source of a sound quite automatically. Sound, as we define it in the sense of a continued sensation, is a dead letter to it. Forel has remarked that insects continue insensible to the sound of the voice if we interpose a screen before the mouth and cut them off from the disturbance of the air. When animal nature acquires the sense of sound as the extreme limit of its perceptions it is to suffer itself to be fascinated, hypnotized, and charmed like the serpent. That continued fixed sensation is to the serpent what the fixity of its look will be to the bird which it will smite in its turn. It is an extreme perception, exceedingly troubling, and away at the extremity of physiological equilibrium, a source of sensorial inhibition, extra-cerebral.

Fishes, which have the power of orientation through the remarkable development of the canals of the labyrinth and their lateral organs directed to all points of their liquid horizon, with such susceptibility to trepidation and disturbances that they perceive the slightest, are only deaf-mutes. I have studied, in my thesis on the Auricular Sense in Space, the transformation of the sense of disturbance into a hearing sense, and the mechanism of auricular orientation in the whole animal series. I only say that all animals possessing the otolithic apparatus in any of its forms perceive, of disturbances of the medium, the intensity, the direction, and the number only, but can not convert them into continuous sensations like those we call sounds. All the experiments and observations invoked as making manifest that invertebrates have hearing only prove the perception of disturbances and tremors, more or less rhythmical modifications of the ambient medium. Of what use would be the perception of sounds in mediums where hardly any sounds are produced? The mollusk fastened to its rock recognizes the approach of a prey or an enemy; it feels the waves breaking upon it; it usually lives on a well-conducting

ground, and by its foot-organ knows all that is passing there. This otolithic apparatus is admirably well adapted to give notice to the mollusk or to the insensitive armor of the crustacean of the least disturbances that pass through the mass into which it is plunged. Every one is acquainted with the experiment of the balls in contact series. A disturbance reaching the end of the chain is betrayed only by the last ball, which is free, and expends in oscillations the shock that is transmitted to it. Equally well known is the process of placing in contact with the vibrating body, plate, or membrane a light substance—sand or cork—the oscillations of which reveal a vibration which our eyes can not discover on the trembling body. In the same way every disturbance traverses the indifferent mass of the animal, and the otolith free in the otocyst, collects it, and announces the slightest shocks to the nervous tissue on which it reposes. The preotolithic formations serve in a similar way. Animals furnished with otoliths can thus analyze rhythms and disturbances which are synthetized in our cochlea into sounds of different tones. The otolithic bell can only reveal a trepidation, and continues unfit to provoke a continuous sensation other than that which results from the persistance of nervous, terminal, or central impressions, a limit beyond which it can not estimate the pitch without such an arrangement as that of the cochlear formations.

As does the spider in the center of its web, stretching with its weight all the vibrating cords that converge toward its fore legs, furnished with otoliths, so can any insect standing on slight legs, stiff and flexible at once, which draw from the ground the slightest tremblings as its antennæ do from the air, distinguish between a thousand significant disturbances, without, after all, perceiving any sensation like what we call sound.

There are, in fact, two fundamental senses which are two forms of touch. The first is immediate touch, under the form of contact when the surface of the object is accessible, or of smell or taste when it is in a state of division, in which it is revealed by its molecular atmosphere. The second touch, at a distance, which is extremely varied, comes by means of the modification of an interposed medium originating in the object that is perceived. Perceptions of electricity and heat are common to both forms.

We ought, *a priori*, to refuse to attribute to insects, whose sensorial organs are so different from ours, senses like those of man. Should not their psychology with more reason be referred to them as a class than to ours? And while it may be legitimate for man to expect to find some of his feelings among the vertebrates which have the most evident relationship with him, that inverse anthropomorphism has a curious appearance which lends our thoughts, wishes, needs, senses, and affections to beings so differ-

ent from us in all respects. It would be at least prudent not to ascribe similar functions to different organs; and our language, the product of our cerebration, would be impotent to represent the emotions of an arthropod or a mollusk; for beings that differ in structure differ also in thought and instinct. The cochlea being adapted to the hearing of simple or composite sounds, tones, or noises, audition proper does not exist where there is no cochlea.

We are, in return, much less well endowed than the spider and crawfish to perceive rapid tremors and vibrations, of which we can make continuous sounds only when they exceed forty in a second.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF PROFESSOR JOHN WINTHROP.

THE name of Winthrop has always been an honored one in New England, in the domain of public affairs, and one member of the family, at least, has placed it high on the rolls of science. Several of the Winthrops of colonial times were cultivators of the sciences, but none employed such high talents so exclusively in this field of activity as did the subject of the present sketch.

JOHN WINTHROP, one of many Johns in that family, was born in Boston, December 19, 1714, and was graduated from Harvard College in 1732. His family history is a part of the history of Massachusetts. His father, Judge Adam Winthrop, was a great-grandson of the first Governor of the Massachusetts Bay Colony; a graduate of Harvard; chief justice of the Court of Common Pleas; colonel of the Boston regiment; and a lay member of the Provincial Council. Six years after graduation, John Winthrop, being then twenty-four years old, was elected to the Hollis professorship of Mathematics and Natural Philosophy by the corporation of Harvard College. The choice being submitted to the overseers of the college, that body appointed a committee "to examine the professor-elect as to his knowledge of the mathematics," which soon reported favorably. Certain of the overseers, who were especially anxious to protect the college from any possible contamination of heresy or schism, tried to have a committee appointed "to examine Mr. Winthrop about his principles of religion." This matter was debated at several meetings, but finally voted down, and Winthrop's election was thereupon approved. He was formally inaugurated, as was then the custom, January 2, 1738–'39. The ceremonies included two Latin orations, the reading of the rules to govern the professor, prescribed by the founder of the professorship, and the singing of a psalm, after which came a dinner.

Soon after entering upon his professorship, in 1740, Winthrop observed a transit of Mercury over the sun, and sent a report of his observations to the Royal Society. This paper was printed in the society's Transactions, and was favorably mentioned in the Memoirs of the French Academy. Prof. Winthrop was thanked by the society, and was asked to continue his communications. Winthrop was now launched upon a long and useful career, during which he was held in high esteem as a teacher of science at home, while his investigations won him much credit abroad. There is sufficient evidence as to his success as an instructor to justify the words of President Quincy, who, in his History of Harvard University, says of Winthrop: "The zeal, activity, and talent with which he applied himself to the advancement of these sciences [i. e., physics and astronomy] justified the expectations which his early promise had raised. As a lecturer he was skillful and attractive, and during forty years he fulfilled the duties of the professor's chair to universal acceptance." Many of his papers on astronomical subjects are to be found in the volumes issued by the Royal Society during his lifetime, among these being an essay on comets, in Latin, entitled Cogitate de Cometis, which he transmitted to the society in 1765, on the occasion of his becoming a member of that body.

On November 18, 1755, an earthquake occurred which terrified the superstitious people of all New England, who regarded it as a direct expression of the wrath of God. To calm the popular terror, Prof. Winthrop read a public lecture on the earthquake in the college chapel. He accounted for such disturbances as being produced by the expansive action of heat upon vapors contained in underground cavities, and argued ably in support of this theory. He also stated that earthquakes had occurred at intervals in New England from the time the first settlers landed, but that not a single life had ever been lost, nor had any great damage ever been done by them. In conclusion, he maintained that earthquakes are "neither objections against the order of Providence nor tokens of God's displeasure, according to the views of skeptical or superstitious minds, but that they are the necessary consequences of general laws." This lecture was published by request of the college authorities, and an account of the earthquake which Winthrop sent to the Royal Society was also printed.

At that time lightning-rods had been invented about three years, and a Boston minister published an essay in which he suggested that the use of Franklin's "iron points" might have caused the earthquake by drawing the electric fluid from the clouds and concentrating it on that part of the earth. This led Prof. Winthrop to add an appendix to his lecture in which he defends the

discoveries of his friend Franklin, and shows the unreasonableness of attributing the earthquake to the action of the rods. He concludes with the hope that he has "fully vindicated the character of those innocent and injured iron points." Some years after, in 1770, he seized another opportunity to defend Franklin's invention, by publishing an essay against the notion that there was great impiety in using lightning-rods, since they prevented the "tokens of Divine displeasure" from "doing their full execution." Under date of October 26, 1770, he writes to Franklin, who was then in London, acknowledging the execution of several commissions concerning books and instruments, and says in regard to the rods: "I have on all occasions encouraged them in this country, and have the satisfaction to find that it has not been without effect. A little piece I inserted in our newspapers last summer induced the people of Waltham (a town a few miles from hence) to fix rods upon their steeple, which had just before been much shattered and set on fire by lightning."*

Prof. Winthrop had a clearer understanding of earthquake movements than the generality of scientific men of his time, and was one of the earliest, if not the first, to apply computation to these phenomena. The chimney of his house was thirty-two feet high, and, observing that bricks were thrown from it so that they fell thirty feet from its foot, he calculated the speed of their motion and found it to be twenty-one feet a second. He perceived also the resemblance between the vibrations of the earth and those of the strings of a musical instrument.

The fullest published account of the scientific work of Prof. Winthrop is contained in the chapter on Boston and Science, contributed to the Memorial History of Boston by Prof. Joseph Lovering, who for over fifty years has occupied the same professorship that Winthrop held. "Prof. Winthrop was fortunate," says Prof. Lovering, "in living at a time when he could be a witness of three celestial occurrences of transcendent importance to the progress of astronomy — namely, the first predicted return of Halley's comet in 1759, after an absence of twenty-seven years, and the transits of Venus across the sun in 1761 and 1769. In 1759 the accuracy of astronomical prediction was on its trial, and, months before the time of the expected visit, astronomers were at their posts and looking; but they were all anticipated by a Saxon peasant who first saw the comet on December 25, 1758. Winthrop saw it on April 3, 1759." He delivered two lectures on comets at this time, which were printed the same year, and reprinted in 1811. Prof. Winthrop also observed the comets of 1769 and of 1770, "one remarkable for its brilliancy and the other for the dis-

* Massachusetts Historical Society's Proceedings, vol. xv, p. 13.

turbances which Jupiter inflicted upon its orbit," and contributed accounts of the phenomena to the Boston newspapers.

Like the earthquake already mentioned, the comet of 1759 aroused considerable popular apprehension, and the following passage from one of his lectures, in which the professor essayed to calm this feeling, will serve as a good sample of his style: "It may not be unseasonable to remark, for a conclusion, that as, on the one hand, it argues a temerity unworthy a philosophic mind, to explode every apprehension of danger from comets, as if it were impossible that any damage could ever be occasioned by any of them, because some idle and superstitious fancies have in times of ignorance prevailed concerning them; so on the other, to be thrown into a panic whenever a comet appears, on account of the ill effects which some few of these bodies might possibly produce, if they were not under a proper direction, betrays a weakness equally unbecoming a reasonable being."

The transits of Venus, which were not to occur again until 1874 and 1882, were precious opportunities for astronomical work, and preparations were widely made to take advantage of them. The governor of the province, Francis Bernard, was interested in the matter by Prof. Winthrop, and sent a message to the House of Representatives, stating that the King of England had sent "a Man-of-War with Mathematicians to be stationed in different Parts of the East Indies, etc.," to observe the transit; that the French king and other powers had taken similar action, the comparison of observations taken in different parts of the earth being important, that Prof. Winthrop had offered to go to Newfoundland for the same purpose, and he therefore recommended that the House furnish the professor transportation on the province sloop, which would be sent to Penobscot a little before the time of the transit. The House of Representatives immediately passed a vote in accordance with this suggestion.

The sloop with Prof. Winthrop on board sailed from Boston May 9th, and reached St. John's thirteen days later. The professor took with him the college instruments and two members of the senior class. Some difficulty was met with in finding a suitable station, but at last a position was taken on a considerable elevation, which was afterward named Venus Hill. The work of setting up the clock and other instruments was made arduous by persecution from swarms of bloodthirsty insects, which had possession of the hill. June 6th was the day of the transit, and the weather proved favorable. In every part of America except Labrador, the phenomenon began before sunrise. At St. John's the sun rose at 4 h. 18 m., with Venus upon its disk, from which the planet passed off at 5 h. 6 m. On his return Prof. Winthrop published an account of his voyage and his observations.

When the transit of June 3, 1769, was approaching he delivered two lectures on the coming phenomenon, which were published. Dr. Maskelyne, then astronomer royal of England, desired that Prof. Winthrop should go to the neighborhood of Lake Superior, where the whole of this transit would be visible, but his health would not admit of this. Accordingly, he saw only the beginning of the passage, as at Cambridge the sun set before it was finished. Prof. Winthrop observed the transit of Mercury January 20, 1763, and prepared an account of it for the Memoirs of the American Academy of Sciences (vol. i, p. 57), of which society he was one of the founders.

As a mathematician and astronomer Prof. Winthrop had no equal in the American colonies, and his fellowship of the Royal Society, together with the degree of LL. D. which he received from the University of Edinburgh in 1771, attests his reputation in the mother-country. Prof. Lovering states that his views of the nature of heat were greatly in advance of the science of his day. His scholarship, moreover, was not limited to his specialty. He wrote Latin with purity and elegance, studied the Scriptures critically in their original languages, and was well versed in the tongues of modern Europe. "He is, perhaps," says Quincy, "better entitled to the character of a universal scholar than any individual of his time in this country." Rev. Charles Chauncy, D. D., in A Sketch of Eminent Men in New England, written in 1768, says: "Mr. Winthrop, Hollisian professor, I have been very free and intimate with. He is by far the greatest man at the college in Cambridge. Had he been of a pushing genius and a disposition to make a figure in the world, he might have done it to his own honour, as well as the honour of the college." *

The office of a professor in Harvard College during the last century was not a lucrative one. The salaries obtained were fluctuating and always small. From about the middle of the century the Professor of Mathematics and Physics received £80 a year. In reply to inquiries made by a committee of the Provincial Legislature, Winthrop wrote a letter in which he stated that his salary had been far from adequate, and that he had run in debt for the support of his family.

Prof. Winthrop married, August 22, 1746, Rebecca, daughter of James Townsend, of Boston, and by this marriage had five sons. His wife died after seven years, and he married again in 1756. His second wife was Hannah, daughter of Thomas Fayerweather, and widow of Farr Tolman, of Boston. She was the well-known correspondent of Mrs. John Adams.

The first vacancy in the presidency of Harvard College that

* Massachusetts Historical Society's Collections, Series I, vol. x, p. 159.

occurred during Prof. Winthrop's professorship was made by the death of President Holyoke in June, 1769. Winthrop presided at commencement that year, and had he been a few years younger (he was then fifty-five) would doubtless have become president of the college. In a letter to Mr. Thomas Hollis, in England, under date of July 10, 1769, Dr. Andrew Eliot, a member of the corporation, remarks: "It is difficult to find one every way qualified to undertake such a task. Mr. Winthrop, Hollis Professor of Mathematics, will probably be the successor to Mr. Holyoke. His learning and abilities are unquestionable. He is older than we could wish, and is frequently taken off from business by bodily infirmities." The office was tendered to Prof. Winthrop, but he declined it. In 1774, when the chair was again vacant, it was offered to Winthrop a second time, and again declined.

The tide of discontent with the mother-country was now running high in the colonies, and Winthrop was clearly identified with the patriot cause. The Massachusetts Historical Society's Collections (Series V, vol. iv) contain a correspondence between the professor and John Adams. The letters cover a period within which occurred the battle of Bunker Hill, the evacuation of Boston, and the Declaration of Independence; and they show that Winthrop had a thorough understanding of public affairs, a fearless patriotism, and an eager desire for American independence. In 1773 he was elected to the Governor's Council, but, together with two other members, all having been opponents of the Government, he was negatived by Governor Gage, in compliance with a special mandate from the English ministry. Prof. Winthrop was chosen a delegate to the Provincial Congress in 1774, and in 1775 was finally admitted to a seat in the Council. About this time he was appointed Judge of Probate for Middlesex County, and held the office for the remaining years of his life. His death occurred in Cambridge, before the Revolutionary struggle was decided, on May 3, 1779.

The portrait which accompanies this sketch has been engraved from a photograph, furnished by Mr. Robert C. Winthrop, Jr., of a painting by Copley, which belonged to the late Colonel John Winthrop, of Louisiana, a great-grandson of the professor, and his last descendant in the male line.

A UNION of friends of astronomy and cosmical physics has been formed in Berlin for the purpose of organizing practical co-operation in these subjects in the countries of central Europe and in their colonies. Sections are formed for observations of the sun, of the moon, of the intensity and color of starlight and of the milky way, of the zodiacal light and meteors, of electrical and magnetic phenomena, and of clouds, hail, and thunderstorms.

EDITOR'S TABLE.

MR. SPENCER ON JUSTICE.

THE volume which Mr. Spencer has just put forth under the title of Justice, being the fourth and last part of his proposed first volume on The Principles of Morality, will be eagerly welcomed by a large circle of readers. It has seldom fallen to the lot of a philosopher to awaken so wide an interest and sympathy as Mr. Spencer has done. We can not speak of him as a "popular" writer, yet he writes for the people, and each successive volume that he publishes finds a wider constituency than its predecessor. His style is not adapted for literary epicures; it is not laden with exquisite flavors, nor rich in tone or color, but it has the higher quality of utter truthfulness. Its aim is not to amuse or to flatter, but to convince, and it ever seeks the most direct road to the candid understanding. In illustration Mr. Spencer is unrivaled; he takes the commonest incidents of life and shows their ethical or philosophical significance in such a way as to stimulate at once the reflective and the observing powers of his readers. If the question were asked, What man has done most to promote the intelligence of mankind in the nineteenth century? we think a very good case might be made out for answering — Herbert Spencer. He is a man to whose philosophy the world at large can grow up, for there is something in it for everybody, dealing as it does with every day realities and appealing to principles that are implicit in the most familiar actions and reactions of our mental and moral life.

When we look into a book of Herbert Spencer's we find ourselves carried out at once into the broad currents of general law; or, to express it otherwise, we find ourselves assisting as spectators at the great drama of life—not the life of a special society or time, but the vast unfolding life of species and tribes from the lowliest forms up to man in his highest development. In dealing with Justice, or the ethics of social life, Mr. Spencer takes us back to the kingdom of the subhuman, and shows us that even there the germ of justice exists, and that the conditions are being prepared for its fuller manifestation. We have only space to glance at a few of the more interesting views which the present volume contains, but these, we think, will suffice to prove that Mr. Spencer has here given us a most substantial and valuable contribution to the discussion of a highly important subject. We venture, indeed, to risk the assertion that this work will set the lines on which all future discussions of the question of justice will more or less be conducted.

The primitive law of justice, according to Mr. Spencer, "implies that each individual ought to receive the benefits and the evils of his own nature and subsequent conduct, neither being prevented from having whatever good his actions normally bring him, nor being allowed to shoulder off on to other persons whatever ill is brought to him by his actions." This law is, however, in the higher animals of a gregarious type, and still more in man, qualified by the self-restraint necessitated by association; that is to say, no individual must push the exercise of his active faculties to such a point as to interfere with the exercise of the similar faculties of his neighbors. The latter principle acquires more and more authority the longer association lasts, and the more highly developed it becomes. Thus the idea of justice comes to consist of two elements —an egoistic one, by virtue of which an individual claims benefits proportioned

to his merits and faculties; and an altruistic one, by virtue of which he recognizes the right of others to such benefits as may be due to their merits or may flow from a proper use of their faculties. These two elements Mr. Spencer also calls positive and negative—the former positive, as putting forward positive claims; the latter negative, as implying a restraint upon natural liberty.

Another important distinction which Mr. Spencer makes is between the ethics of the family and the ethics of the state. In the family the young have to be cared for, and, in their case, benefits have to be proportioned, not to merits, but to needs, which, in a certain sense, may be described as lack of merits; in other words, the less a child can do that is beneficial to others the more care and attention it must receive. The state, on the other hand, deals with adults, and its guiding principle therefore should be exclusively—benefits according to merits, evils according to demerits. Only confusion and trouble can arise, according to Mr. Spencer, from applying the ethics of the family to state action. He is willing that individuals should exercise a prudent benevolence if they will, but he sees no reason why the state should ever depart from the strictest rule of justice. In discussing The Constitution of the State and the question of giving women the suffrage, he makes the following significant remarks: "Human beings at large, as at present constituted, are far too much swayed by special emotions temporarily excited and not held in check by the aggregate of other emotions; and women are carried away by the feelings of the moment more than men are. This characteristic is at variance with that judicial-mindedness which should guide the making of laws. . . . At present both men and women are led by their feelings to vitiate the ethics of the state by introducing the ethics of the family. But it is especially in the nature of women, as a concomitant of their maternal functions, to yield benefits not in proportion to deserts, but in proportion to the absence of deserts—to give most where capacity is least. . . . The present tendency of both sexes is to contemplate citizens as having claims in proportion to their needs—their needs being habitually proportionate to their demerits; and this tendency, stronger in women than in men, must, if it operates politically, cause a more general fostering of the worse at the expense of the better." These are weighty words, and we can not but hope they may not be entirely inoperative on the minds of modern legislators.

On the subject of political rights our author does not strike at all a popular key. In the chapter entitled Political Rights—so called, he says that such rights are not, strictly speaking, rights at all. A man's substantial rights are, he says, the right to physical integrity, the right to free motion and locomotion, the right to the use of natural media, the right of property, the right of incorporeal property, the right of gift and bequest, the right of free exchange and free contract, the right of free industry, the right of free belief and worship, and the right of free speech and publication. As to political rights, they are merely the supposed means of obtaining the above real rights; and serious mischiefs have resulted from confusing them with real rights. It has been assumed that where political rights were possessed by all, the liberty of all would be secure; but, far from this being the case, we can not fail to observe that, "where so-called political rights are possessed by all, rights properly so called are often unscrupulously trampled upon." For example, "universal suffrage does not prevent the corruptions of municipal governments, which impose heavy local taxes and do very inefficient work, . . . does not prevent citizens from being coerced in their private lives by dictating what they shall not drink; does not prevent an enormous

majority of consumers from being heavily taxed by a protective tariff for the benefit of a small minority of manufacturers and artisans." So-called political rights *may* be used for the maintenance of liberties; but "they may fail to be so used, and may even be used for the maintenance of tyrannies."

In his discussion of the Nature of the State we see an illustration of the vast superiority of Mr. Spencer's method over that employed by writers of a simply historical or literary school. Sir Frederick Pollock, in his Introduction to the Science of Politics, says that, to arrive at a true idea of the nature and functions of the state, he can give no better advice than "Back to Aristotle!" Mr. Spencer, on the other hand, shows clearly why Aristotle, advanced thinker as he was for the age in which he lived, can not serve us here, the state, in its essential constitution, being no longer what it was in his day. Very instructive indeed is the contrast which our author draws between the state in a period of perpetual warfare and the state in an era of peaceful industry. In the former case it is obliged to tyrannize over its own citizens; in the latter, it has nothing to do but to see that they do not unduly interfere with one another. Justice in all matters, civil as well as criminal, ought, in the present day, the author holds, to be a right of the individual citizen, to be enforced without cost on application to the proper tribunal. In answer to the objection that, if justice in civil cases could be had without cost, there would be a perfect blockade in the courts, Mr. Spencer declares that, if justice were thus obtainable, the number of offenses would be enormously reduced, which doubtless is true. There are some very interesting chapters in the book on The Limits of State-Duties, which we can not too strongly recommend to the attention of our readers. Mr. Spencer effectually disposes of the notion, so common in our days, that majorities can do no wrong, and that men can not be slaves under a republic. There is a strong temptation to reproduce some of his vigorous and manly utterances on this topic, but we must refrain. It is a great satisfaction to find that Mr. Spencer is again at work, and that there is a prospect that his vast philosophical undertaking will be advanced yet further toward completion, or may even be fully accomplished before he lays down the pen. The volume before us shows a mind as vigorous and as fertile as ever, and the same high, unflinching purpose to effect a great and enduring work of intellectual emancipation and moral regeneration for mankind.

DUTY AS A SCIENCE.

Among the most noteworthy of the summer schools of 1891 was the School of Applied Ethics at Plymouth, Mass. Its formation was due to some of the most successful teachers in America, who had become convinced that, were right conduct cultivated as a science, it would be better practiced as an art; that with due adaptation it should form a part of all education—with, indeed, the aim that schools in every department should be pervaded and vitalized by an ethical atmosphere. From this school's foundation we feel sure will date a new impulse freighted with good to individual character and national life. Since conduct has been so much under the sway of religion, it was fitting that the great faiths of the world should receive extended study. With all the resources of modern scholarship Prof. Toy, of Harvard, set forth the rise and progress of religious ideas, the transformation from faith in many gods to belief in one, the slow crystallization of oral traditions into scriptural canons, the emergence of ethical codes from associations of mythology and ritual. Of his masterly lectures the best lesson lay in their calm scientific spirit. While crediting religions with having given authority to

high ideals, he pointed out the inevitable injury which had come from imagining these ideals to be incapable of either lift or expansion. Other lecturers, who have devoted themselves to the study of special faiths, supplemented the discourses of Prof. Toy.

In economics, with incidental excursions into the political sphere, the chief expositions were by Prof. H. C. Adams, of Michigan University. He graphically sketched the history of recent industrial development, and showed how new exigencies had arisen for which adaptations of law and organization were necessary. An era when the massing of machinery is necessary to production, and when monopolies raise their heads on every side, is not to be justly ruled by institutions dating from a time when manufacture was armed with simple tools, and in which over a race of small producers free competition reigned. He viewed with sympathy the growth of trades-unions, regarding them as the chief agency for securing rightful wages. For monopolies he considered the fit check to be the commission, State or Federal, such as now supervises railroads. Publicity of transactions would educate public opinion to demanding public rights. His elucidation of the functions of a commission, and his declaration of faith in its principles, were candidly accompanied by the opinion that so far the Interstate Commerce Commission had not justified its existence. Its four years of life had been too short for legal definition of its powers; it lacked authority to give its opinions effect. President Andrews, of Brown University, in a series of three lectures, set forth "the social plaint," socialism's remedy, and "the better way." His account of the evils under which the masses suffer included everything that intelligent discontent can say. To his rapid survey of socialistic doctrine no socialist could demur. In his view the woes of society will be cured not in one way but many, and along paths in which important steps have been already taken; for example, in profit-sharing and other modes of co-operation. He would reform taxation by making the chief levies on land values, and on the great franchises whose profit is of public creation. In the development of statistical inquiry he saw prospect of relief from industrial crises through an organized adjustment of supply to an ascertained demand. He looked with hope on the beginning which has been made in teaching people how to buy food and cook it, and how to expend their earnings to most advantage. The lessons in practical thrift now introduced in a few schools he deemed worthy of general adoption. In this department of economics men of authority described co-operation, factory legislation, the relief of crowded cities, and modern agrarian movements, including the Farmers' Alliance.

In ethics proper the principal lecturer was Prof. Felix Adler, who, drawing upon his experience with ethical classes in New York, delineated how right conduct may be taught. On the threshold of his subject he confronted the question as to how morals can be taught apart from religion. He averred that a most important body of moral doctrine exists as the common heritage, not only of all religions, but of all men of sound mind and heart. On this he would proceed, teaching authoritatively and ignoring the consideration of sanctions, whether religious or philosophical, which indeed young minds can not weigh. He then outlined the motives of good conduct, the ethicization of the feelings, the duties of self-control, self-improvement, veracity, justice, and charity. Following this came treatment of the ethics of the family, of professional and business life, of citizenship. He indicated the aid which stories afford in teaching young classes; which biography, proverbial and scriptural literature, and history contribute in advanced classes. Throughout the course

the interplay between intelligence and conscience was made very clear; plainly did it appear that without knowledge, and much knowledge, without a judgment trained to nice discrimination, the desire to do right and justice in these days of complex social life must be vain. In this department summaries of experience in reform were added by men who have devoted their lives to seeing the Indian righted, the wretched in cities relieved, the prisoner born to new hope and purpose.

LITERARY NOTICES.

JUSTICE: Being Part IV of the Principles of Ethics. By HERBERT SPENCER. New York: D. Appleton & Co. 1891. Pp. 291.

THE appearance of a new volume of the Synthetic Philosophy after a long enforced interval of rest on the part of its author is an event which merits the hearty congratulation, not only of the avowed disciples of Mr. Spencer in America—a goodly and growing number of our most intelligent thinkers—but also of all friends of scientific and liberal thought.

It is now twelve years since the publication of the Data of Ethics. As was then announced, this volume was issued in advance of the regular order of publication, under the pressure of premonitions of failing health. Similar considerations have impelled Mr. Spencer to leave unfinished the concluding sections of The Principles of Sociology and intervening parts of The Principles of Morality, in order to apply himself to the exposition of the law of Justice, which we have his explicit warrant for regarding as the consummate fruit of his patient study and discriminating thought. The noble volumes which have preceded it are all subsidiary to the practical application of the principles of Justice to the pressing problems of our societary life.

Viewed from the standpoint of the philosophical evolutionist, nothing surely could be more timely than the appearance of this work. The past decade has been an era of crude and rash speculation upon social and political problems. In America, no less than in England, we have need to listen to the voice of one who looks neither to the inventions of a closet-philosophy nor to the chance-suggestions of the political empiricist, but to the eternal laws of Nature for wise counsel and enlightenment upon these vast issues. We have recently listened to enthusiasts who expect to abolish poverty and reform society by the simple panacea of the single tax; we have seen a political party spring into an ephemeral existence based upon the success of a visionary novel—the effort of a professional story-writer to imagine a society constructed on principles as foreign as possible to those illustrated in the existing social order. Another political organization promises to abolish crime and regenerate human nature by the simple expedient of prohibiting the manufacture and sale of alcoholic drinks; and anarchistic agitators would abolish the evils of society by the short and easy method of abolishing society itself. It is refreshing to turn from this array of absurdly inadequate panaceas to the wise and conservative counsels of Mr. Spencer, whose more than seventy years, with whatsoever burdens of physical infirmity they may have afflicted him, have detracted nothing from his logical acumen, his clarity of thought, or lucidity of diction.

The first six chapters of the present volume were published in The Nineteenth Century and The Popular Science Monthly in the spring of last year, and their tenor will readily be recalled by the readers of these periodicals. Defining the highest conduct as "that which conduces to the greatest length, breadth, and completeness of life," Mr. Spencer shows that we must seek for the germs of morality in the animal world. He goes further, and shows that human morality is based upon laws which are as universal as life itself, and are active and potent in the development of all living things. The reference to these underlying biological principles runs all through the present volume, and differentiates the treatment of its topics from that of his earlier work, Social Statics, which aimed to cover much of the same ground. Social Statics, however, was not the product of Mr. Spencer's mature thought. He has long been conscious of its imperfections. In the successive volumes of his Synthetic Philosophy he has substituted an exclusively natural or evolu-

tionary treatment for the partially supernatural explanations implied in Social Statics, has made a freer use of the inductive method in support of his deduced principles of ethical and social growth, and has given the law of relativity greater prominence as influencing his practical conclusions, some of which, as expressed tentatively in Social Statics, have been modified or rejected in the present volume.

Defining the objective law of subhuman justice as that social condition wherein "each individual shall receive the benefits and evils of its own nature and its consequent conduct," Mr. Spencer also points out that among gregarious creatures this objective law is modified by the necessity for self-subordination and occasional self-sacrifice in the interest of the species. Human justice is simply a natural development of subhuman justice. The growing necessity for co-operation imposes an increasing obligation for individual restraint; and the social sentiments, of which the sentiment of justice is chief in importance, are correspondingly evolved.

An important difference is pointed out between family ethics and the ethics of the state. In the former the obligations of parents are conditioned upon the children's needs, while in the latter obligations are proportioned to the nature and actions rather than the needs of the individual. A clear distinction is drawn between the *sentiment* of justice and the *idea* of justice. The former may be strong, while the latter is relatively weak. Men may understand clearly that they ought to deal justly by their neighbors, but have a very imperfect comprehension of the course of action which justice requires. The primary characteristic of the idea of justice, contrary to the popular understanding, is that of *inequality*. The natures and consequent activities of individuals are greatly unequal. Justice, therefore, requires that they shall receive correspondingly unequal rewards. The spheres or opportunities of all, however, should be mutually bounded, and hence approximately equal. The formula of justice may accordingly be expressed by saying, "Every man is free to do that which he wills, provided he infringes not the equal freedom of any other man."

Mr. Spencer incidentally defends with great ability the approximate validity of fixed intuitions or deductions against the positivistic disciples of an exclusively inductive method of reasoning. Such intuitions, he shows, "must have been established by that intercourse with things, which, through an enormous past, has, directly or indirectly, determined the organization of the nervous system and certain resulting necessities of thought." Ethical intuitions, however, require the correction of methodic criticism and the application of inductive tests. Both methods work together for the discovery of truth.

In the subsequent chapters the rights and duties of individuals and governments are deduced from the foregoing principles. Man's fundamental right is declared to be that of physical integrity. Under the law of relative ethics this right can only be perfectly maintained in a state of permanent peace. The rights of man to free motion and locomotion are next asserted—rights which conflict, of course, with all forms of serfdom or slavery. The recognition of these rights is said to have been of very recent origin. In early times "the conception of freedom as an inalienable right had little or no place either in ethics or law. . . . Neither Christ nor his apostles denounced slavery." It may, however, be maintained by Christian apologists that certain seed-principles contained in the Gospels are in logical conflict with slavery, and exerted a powerful though indirect influence toward its overthrow.

In the important chapter on The Right to the Uses of Natural Media, after noticing some of the habitual infringements on the admitted right of all to free light and air—as by smokers in public places, injurious fumes from chemical works, bad street music, etc.—Mr. Spencer attacks the much-agitated land question. He reaffirms the principle laid down in Social Statics, that all men have a natural right to the use of the soil—a right which, he strongly asserts, has everywhere been alienated by force and fraud. Its fundamental character is now tacitly admitted, however, he claims, in the universally recognized principle of eminent domain, in defense of which he quotes Sir Frederick Pollock. His final conclusions on this subject, however, will not be acceptable

to the followers of Henry George. After calling attention to the great difference between the value of the land in its primitive state and its present value, and to many practical difficulties in the way of the resumption of state-ownership, Mr. Spencer says:

. . . "The landless have not an equitable claim to the land in its present state—cleared, drained, fenced, fertilized, and furnished with farm buildings, etc.—but only to the land in its primitive state; . . . this only it is which belongs to the community."

Referring to his argument for communal ownership in Social Statics, he declares, "A fuller consideration of the matter has led me to the conclusion that individual ownership, subject to state-suzerainty, should be maintained.

"Even were it possible . . . to make a rearrangement equitable in the abstract, the resulting state of things would be a less desirable one than the present. . . . It suffices to remember the inferiority of public administration to private administration, to see that ownership by the state would work ill. Under the existing system of ownership those who manage the land experience a direct connection between effort and benefit, while, were it under state-ownership, those who managed it would experience no such direct connection. The vices of officialism would inevitably entail immense evils."

In affirming the right of the individual to property in general as against the communistic idea, Mr. Spencer is particularly clear and cogent, showing that the fundamental law of justice can only thus be fulfilled.

The right of incorporeal property, as in copyrights and inventions, is clearly and logically asserted. The right to sue and obtain damages for unjust assaults on personal reputation is also defended. Mr. Spencer maintains, however, in opposition to prevalent legal custom, that there is no ethical warrant for the punishment of a person who injures the reputation of another by stating unpalatable truths in regard to him. The exposure of a false reputation, he says, may often prove a public benefit. The rights of gift and bequest follow as legitimate deductions from the foregoing principles applying to property and land.

The advocates of a "protective" tariff will hardly derive much comfort from Mr. Spencer's discussion of The Rights of Free Exchange and Free Contract. The only legitimate qualification of these rights which Mr. Spencer admits is "where there is good evidence that freedom of exchange would endanger national defense." "Those who have been allowed to call themselves 'protectionists' should be called aggressionists; since forbidding A to buy of B, and forcing him to buy of C (usually on worse terms), is clearly a trespass on that right of free exchange which we have seen to be a corollary from the law of equal freedom."

Mr. Spencer asserts the rights to free belief and free worship in a clear though brief statement, deeming any lengthy argument in their support unnecessary. The rights of free speech and publication are likewise lucidly and forcefully maintained; free speech being "still the agency by which error is to be dissipated." On the delicate question of the discussion of the matters of sexual morality, Mr. Spencer argues from historical data that it is not reasonable to take for granted that our own customs are above criticism, and holds that the evils incident upon a free discussion of such topics "must be tolerated in consideration of the possible benefits." Public opinion, he thinks, may be trusted to hold these evils in check.

In a retrospective chapter, Mr. Spencer adduces several lines of deductive and inductive verification of these principles, holding that the convergence of all these lines of inquiry justifies us in regarding the law of equal freedom as of supreme ethical value, leading us to conclusions involving "as great a certainty as can be imagined."

The important chapter on the Rights of Women gives evidence of the careful consideration of a difficult problem by a just, conservative, and well-balanced mind. Mr. Spencer holds that women, as the weaker sex, should not be artificially disadvantaged in the struggle for life. He asserts that "no restraints can equitably be placed upon women in respect to the occupations, professions, or other careers which they may wish to adopt." In the final adjustment of property rights he thinks that "the discharge of domestic and maternal duties by the wife

may ordinarily be held a fair equivalent for the earning of an income by the husband."

As to political rights or privileges, he holds that those of women are not to be regarded as identical with those of men. With men, the possession of the suffrage involves the obligation to become military defenders of the nation. Women have not the same liabilities; hence, if they are granted identical privileges, their position is not one of equality but of superiority to men. The question of equal political rights for women can not be entertained, he argues, until we reach a state of permanent peace. In criticism of this view, it may be maintained, we think, in accordance with a logic which Mr. Spencer has himself recognized in treating of the property rights of women, that the question is not so much one of identity of function and obligation as of just equivalence. Even in case of war, it may not unjustly be held that the services of women, in the hospital and in the home, as tax-payers and wage-earners, as mothers and educators of the country's defenders, constitute a fair equivalent to the services of men in the field, and entitle women to equal political consideration, all other conditions being identical. Moreover, large classes of men are legally exempt from military service, by age, occupation, or physical disqualification, but such persons are not therefore disfranchised. Evidently, therefore, suffrage is not conditioned, *de facto*, upon military service or ability therefor. Nor, happily, are the problems of government mainly those growing out of physical conflicts between nations. The arguments against enfranchising women in the later chapter on The Constitution of the State, based on their constitutional differences from men—their comparative impulsiveness, emotional susceptibility, and relative inability to recognize the force of abstract and remote considerations, bearing upon the public welfare—appear to us to have much greater weight than the by no means novel argument based on the incapacity of women for military service. They will doubtless seem to many minds at present conclusive. Mr. Spencer, it should be said, expressly disclaims the application of this argument as an objection to local or municipal suffrage for women.

In discussing the rights of children, the reciprocal duties of parent and child are clearly outlined, and the necessity of giving the child a gradually increasing freedom of action to fit him for the independent or self-directed activities of his adult life is strongly affirmed.

With a notable series of chapters on the nature, constitution and duties of the State, Mr. Spencer concludes the present volume. In many respects these chapters constitute the most suggestive and valuable part of this discussion. Nowhere else have the nature and duties of citizenship, and the proper limitations of state-control over the individual, been so clearly and tersely set forth. With admirable brevity and lucidity, Mr. Spencer first shows the fallacy of the eighteenth-century doctrine of political rights, a doctrine which still finds intelligent supporters, especially in democratic and republican communities like our own. The only rights, truly so called, which man possesses, he affirms, are the personal rights to life, freedom, security, etc. Political privileges are instrumental, in greater or less measure, depending on the state of culture and civilization, in maintaining these rights; and they can only be claimed in virtue of their efficiency in securing this end. "The giving of a vote," e. g., "considered in itself, in no way furthers the voter's life, as does the exercise of those various liberties we properly call rights. All we can say is that the possession of the franchise by each citizen gives the citizens in general the power of checking trespasses upon their rights; powers which they may or may not use to good purpose" (page 177).

Attention is called to the fact that in France the bureaucratic despotism is as great under the republic as it was under the empire; and that in America universal suffrage does not prevent corruptions of municipal government, the surrender of power to wire-pullers and bosses, the coercion of the citizens by laws dictating what they shall not drink, and the taxation of the many for the benefit of the few by a "protective" tariff. "The so-called political rights may be used for the maintenance of liberties, they may fail to be so used, and may even be used for the establishment of tyrannies."

In considering The Nature of the State,

it is pointed out that "the end to be achieved by the society in its corporate capacity, that is, by the state, is the welfare of its units; for the society having as an aggregate no sentiency, its preservation is a desideratum only as subserving individual sentiencies." This is a most important principle, which should always modify the modern evolutionary conception of society as an organism, and prevent that subordination of the individual which must result from the application of socialistic principles to governmental affairs. The modern state, Mr. Spencer shows, is in process of evolution from the militant type, in which successful aggressive activities demand and develop the principle of centralization, toward the industrial type, based upon contract. In its final development the constitution of the state "appropriate to that industrial type of society in which equity is fully realized, must be one in which there is not a representation of individuals but a representation of interests. For the health of the social organism and the welfare of its members, a balance of functions is requisite; and this balance can not be maintained by giving to each function a power proportionate to the number of functionaries." This principle, which constitutes, perhaps, the most suggestive and original part of Mr. Spencer's discussion of governmental methods, will doubtless meet with much opposition and criticism in our own and similarly constituted communities. It is evidently, however, the product of a most careful study of existing societies, and a judicial consideration of their obvious merits and defects. It is worthy of the thoughtful attention of all students of society and government.

In discussing the duties of the state, Mr. Spencer argues that as societies advance from the militant toward the industrial type, state functions will be less and less adapted to repelling external aggressors and more and more to the maintenance of the conditions of justice against the assaults of internal enemies—the ignorant, vicious, and depraved, who constitute abnormal elements in all large societies. For the better fulfillment of this obligation, he believes it to be the duty of the state to administer justice without cost—to arbitrate between citizens gratuitously. His arguments in this behalf, and replies to anticipated objections, are forceful and worthy of the serious attention of our statesmen and philosophers. A further duty of the state is to act as trustee for the supervision of the inhabited territory, with reference to the building of roadways, canals, and railroads; the establishment and repair of water, gas, telegraph, and kindred appliances, etc. The actual introduction and maintenance of public works should, however, usually be left to private enterprise. The paternal theory of government contradicts the fundamental principles of justice by introducing into the state the contrary ethics of the family. "The only justification for the analogy between parent and child and government and people," he says, "is the childishness of the people who entertain the analogy" (page 217).

No candid and thoughtful man, unbiased by socialistic preconceptions, can read the concluding chapters of this book without being convinced that the true progress of governmental institutions must lie along the lines which Mr. Spencer has indicated. The philosophical evolutionist can but agree with him that "all-embracing state-functions characterize a low social type; and progress to a higher social type is marked by a relinquishment of functions" (page 230). The vices and inefficiencies of the civil service, so lucidly described in these chapters, are defects of our American institutions no less than of those of the mother-country. Wherever they exist they are largely due to the failure to comprehend and apply the fundamental principles of equity and justice, so well defined by Mr. Spencer. So far as these false methods are defensible at all, they are habitually defended by arguments avowedly based on considerations of custom and immediate utility. It should be evident, however, none the less to us than to Mr. Spencer, that "this empirical utilitarianism, which makes happiness the immediate end, stands in contrast with the rational utilitarianism, which aims at the fulfillment of the conditions of happiness." The excellence and sufficiency of Mr. Spencer's ethical theory nowhere appeal so conclusively to the enlightened understanding as under the crucial test of its practical applications. The thoughtful moralist who is thoroughly acquainted with the facts of our existing societary conditions can hardly avoid the conclusion thus

tersely expressed in the final chapter of this work:

"The end which the statesman should keep in view as higher than all other ends is the formation of character. And if there is entertained a right conception of the character which should be formed, and of the means by which it may be formed, the exclusion of multiplied state agencies is necessarily implied."

As we ponder upon the wise counsels of this noble exposition and defense of the principles of justice, we may well congratulate ourselves, as Americans, that we were early to discover the genius and ability of him whom Mr. Darwin well named "our great philosopher." We may likewise congratulate Mr. Spencer on the renewal of health which has enabled him to make this most important contribution to the literature of ethics and philosophy. May we not hail it as a harbinger of hope that his strength will be husbanded and his life prolonged for the complete accomplishment of that self-imposed task which, even in its present unfinished state, constitutes unquestionably the greatest literary achievement of the present century?

STUDIES OF THE GODS IN GREECE AT CERTAIN SANCTUARIES RECENTLY EXCAVATED. By LOUIS DYER. London and New York: Macmillan & Co. Pp. 457. Price, $2.50.

THESE studies were originally given in eight lectures delivered in 1890 at the Lowell Institute. They were repeated before various universities, colleges, and societies in the United States, and are now published with corrections and notes, the fruit of a year's deliberation. The author seems to be inspired by an enthusiasm for the Greek religion similar to that which Schliemann had for its Homeric associations. To him it was the beautiful and ennobling religion, first of Greece, and then—through Greece and Rome—of all the ancient world; and the sanctuaries where it had its growth were places "where that old-time worship of ideals, by some miscalled idolatry, grew pure and yet more pure, broad and broader still, until its inner significance and truth were no longer to be confined within old forms, could be fettered no longer by old bands; and lo! Christianity was there to gather in a heritage of high-born thoughts from Greece." To the religion of Greece and Rome, the author says in another place, "to the Eleusinian mysteries, to the worship of Æsculapius and Apollo, to the adoration of Aphrodite, is due more of the fullness and comforting power of the Church to-day than many of her leaders have been willing to allow." In the spirit revealed by these words, of judging Greek religion not by all its moods, but by all its highest and most characteristic ones, are discussed the worship of Demeter and Persephone, and of Dionysus at Eleusis, of Æsculapius at Athens and Epidaurus, of Aphrodite at Old Paphos, and of Apollo at Delos, on all of which light has been cast by recent excavations at their particular shrines. Various corollaries of the main subject are considered in appendixes; and plans are given of three of the temples.

ELECTRICITY: THE SCIENCE OF THE NINETEENTH CENTURY. By E. M. CAILLARD. New York: D. Appleton & Co. Pp. 310. Price, $1.25.

THIS volume appeals to the large class of educated readers without scientific training who may wish for some comprehension of electrical principles. No mathematical computations or technical processes are given, but the resultant laws are clearly stated, illustrated by interesting experiments and explanations of recent inventions. The author has made four divisions of her work: Static Electricity; Magnetism; Current Electricity; and Appliances of Electricity. Under the first head a brief outline of electrical development and elementary facts is followed by a description of frictional machines and the "electrophorus." A "charge" is produced because "all bodies are not equally good conductors," and the storing of electricity is compared to the accumulation of water, the insulator acting similarly to a dam. As the existence of air is shown by the wind-storm, so the presence of electricity is exhibited in discharge. "Potential" is defined as the comparative electrical condition of a body. If the same amount of electricity be conveyed to two different bodies, the smaller one may be at high potential and the larger at low potential, "potential" bearing the same relation to electricity that level bears

to water. The Leyden jar is an example of two conductors separated by an insulating medium and may be used to exhibit some of the recent discoveries as well as simpler phenomena. An analogy is found for the charged Leyden jar in the atmospheric condition preceding a thunderstorm when the air between the earth and clouds is under the same strain as the glass.

The theory of molecular magnetization accounts best for the properties of magnets and the study of terrestrial magnetism confirms the coincidence of magnetic storms and sun-spots. All electrical manifestation results in discharge, but current electricity consists in a *continuous* flow. The usual way of producing this by galvanic battery, the chemical, physiological, and magnetic effects are next examined. The practical units of measurement, the *volt*, *ohm*, *ampère*, and *coulomb*, are usually employed with prefixes signifying a million-fold or millionth, thousand-fold or thousandth. In the last section various magneto-electric, dynamo machines, and electric motors are described and illustrated; also, electric lighting, railways, telpherage, the telephone, and many minor electrical devices; and the application of electricity to metallurgy in electro-plating, electrotyping and welding. The nature of electricity is discussed. Since the detection of electro-magnetic waves that can be reflected, refracted, and polarized like those of light, the "electro-magnetic theory of light" has been accepted and "we may say that electrical science includes the whole of optics, or that optics includes the whole of electrical science, whichever way we like to put it."

THE CRIMINAL JURISPRUDENCE OF THE ANCIENT HEBREWS. Compiled from the Talmud and other Rabbinical Writings, and compared with Roman and English Criminal Jurisprudence. By S. MENDELSOHN. Baltimore: M. Curlander. Pp. 270. Price, $2.50.

THE author of this book is Rabbi of the Jewish congregation "Temple of Israel," at Wilmington, N. C. He is described as a man of great learning, and the accuracy of his work is testified to by prominent Hebrew clergymen on the side of Talmudic data, and by "lawyers of renown" on that of the civil and common law. His purpose in preparing it has been to acquaint the world with the system of criminal jurisprudence unfolded in the Talmud, and to contribute to the vindication of the Israelitish people's ancient literature from aspersions which have been cast upon it. His language on the latter point leads us to infer that he hardly realizes the attention Talmudic literature has received in later days from students, and underrates the respect in which it is held by theologians and scholars. In the course of his essay he unfolds the thesis that the system of criminal jurisprudence of the ancient Hebrews, as recorded in the Talmud and contemporaneous rabbinic literature, was one which enforced civil order and secured the safety and peace of society by mildness and consideration; and this in an age of savagery and violence, of wars and uncertainty. While in England, one hundred years ago, one hundred and sixty offenses were punishable with death, that penalty was inflicted among the Hebrews for only thirty-six offenses. The *lex talionis*, an eye for an eye, etc., prescribed by Moses, and not unknown to the old English law, gave way, under the rabbis, to a pecuniary compensation; and it was the custom of the rabbis, sitting in judgment over a human being, to lay every possible legitimate obstacle in the way of conviction. In the body of the work a syllabus is furnished of the principal penal statutes established by the ancient Jews and preserved in the Talmud and contemporaneous rabbinical books, under the headings of Crimes and Punishments, The Synhedrion, The Trial, and The Execution. An account of the Talmud, historical and analytical, is given in an appendix.

AN INTRODUCTION TO THE STUDY OF BOTANY. By EDWARD AVELING. New York: Macmillan & Co. Pp. 363. Price, $1.10.

THIS volume is intended as a guide to the practical study of the subject, and assumes no knowledge of it on the part of the reader. The syllabus of the Science and Art Department at South Kensington is taken as a basis for the general plan of the work, but it is intended to help all who enter upon the study, no matter what particular end they may have in view. The lessons are expected to be taken from the plant, and

the book to be subsidiary to the practical study. Following the method of working from the known to the unknown, it begins with the examination and description of familiar plants; and, in learning to dissect and describe those objects, the student will also be mastering the general and the special morphology, histology, and physiology of the plant. The first chapter gives the general definitions of botany and its divisions. In the second chapter the buttercup is taken up for dissection and description, and its characteristics and relationships are brought out as typical of the *Ranunculaceæ*. In a similar way the succeeding chapters deal with typical examples of other orders; after which the student is introduced to "The Vegetable Cell," "Cell Contents," "Tissues and Systems," "The Root," "The Stem," "The Leaf," "Inflorescence, Floral Organs, and Fruits," and "Classification."

TAXIDERMY AND ZOÖLOGICAL COLLECTING. By WILLIAM T. HORNADAY. New York: Charles Scribner's Sons. Pp. 362. Price, $2.50.

MR. HORNADAY aims, in this volume, to present a complete hand-book for the amateur taxidermist, collector, osteologist, museum-builder, sportsman, and traveler. The author speaks of it as "an affair of the heart," and hopes that "it may be the means of materially increasing the world's store of well-selected and well-preserved examples of the beautiful and interesting animal forms that now inhabit the earth and its waters." He thinks that previous works on the subject are not practical enough, saying, "The average book on taxidermy contains four times too much 'padding,' and not one quarter enough practical information," and would remedy the defect. As a reason for publishing such a book now, he urges: "The rapid and alarming destruction of all forms of wild animal life which is now going on furiously throughout the entire world renders it imperatively necessary for those who would build up great geological collections to be up and doing before any more of the leading species are exterminated"; and "*Now* is the time to collect. A little later it will cost a great deal more, and the collector will get a great deal less; . . . and it is my firm belief that the time will come when the majority of the vertebrate species now inhabiting the earth in a wild state will be either totally exterminated or exist only under protection. But do not launch out as a collector until you know how to collect. The observance of this principle would have saved the useless slaughter of tens of thousands of living creatures, and prevented the accumulation of tons upon tons of useless rubbish in the zoölogical museums of the world." The caution in these passages is more important than the incitement. There are too many collectors abroad and they are too indiscriminate. It would be well to reduce the number and select from them, and then give the selected ones such a book as Mr. Hornaday's. Some species are in as much danger from collectors as from any other source; and all species, when collected, should be put to the best possible use for instruction. Mr. Hornaday's book excellently fulfills its purpose, and avoids the faults he finds with its predecessors. It gives full information, in six parts, on collecting and preserving mammals, birds, reptiles, fishes, marine invertebrates, and birds' eggs and nests; taxidermy, mounting, and group-making; making casts; osteology, or preparing and mounting skeletons; the collection and preservation of insects; and general information respecting insect pests and poisoning, books of reference, etc. It is handsomely and liberally illustrated by Charles Bradford Hudson and other artists. The chapter on Collecting and preserving Insects is by Dr. J. W. Holland, and the author acknowledges obligations for assistance to other experts.

A PRIMER OF ETHICS. Edited by BENJAMIN B. COMEGYS. Boston: Ginn & Co. Pp. 127.

THERE can be no question that Mr. Comegys has prepared a timely text-book. Character training is equally if not more important than mental or manual training, but receives scant attention. Carelessly considered as inseparable from religious instruction, it has been left to the Church, and the Church now concerns itself with creeds rather than conduct. An old maxim holds good in this instance, for between church, home, and state, the most needed education is treated in hap-hazard fashion and falls to the ground, while multitudes grow up to man-

hood and womanhood without other moral instruction than what they may have inhaled with the air, and possessing such notions of rectitude that they might be put to the blush by a barbarian.

The handy little volume that suggests right and wrong as worthy subjects for study is founded upon the Rollo Code of Morals, by Jacob Abbott. This has been abridged and altered to suit present needs. The contents include a score of lessons upon fundamental duties. A principle is stated in concise form at the beginning of each lesson; stories illustrating it, or any deviation from it, follow; and, in conclusion, questions are given, not only upon the subject-matter furnished, but upon other cases not mentioned in the text, thus stimulating the pupil to think for himself. The arrangement is admirable, the language simple and direct, and the stories such as to interest children. Now that the book is written giving primary ethical truths without religious doctrine, it is to be hoped that it will be put into immediate use. It may possibly be objected by school committees that, although containing no more theology than simple theism, it has a pronounced political bias. It undoubtedly tends to discourage party rings and truckling to power, and may thus be construed to openly aid and abet civil-service reform. Yet, as no code of morality can be drawn up of sufficient latitude for political use, it can be explained to the pupil that electioneering and lobbying form exceptions to ethical rules.

PUBLICATIONS RECEIVED.

Agricultural Experiment Station Bulletins and Reports. Delaware College. Leaf-blight. Pp. 16.—University of Illinois. Experiments in Pig-feeding. Pp. 30.—Iowa. Various Subjects. Pp. 120.

Allen, J. A. New Species of Mice from Costa Rica and Mexico. Smithsonian Institution. Pp. 4.

Bolles, Frank. Yellow-bellied Woodpeckers and their Uninvited Guests. Pp. 12.

Boston Society of Natural History. Proceedings. May to December, 1890. Pp. 182.

Coinage of Gold and Silver. Report of Congressional Committee. Pp. 156.

Dall, William H. New or Interesting West American Shells. Smithsonian Institution. Pp. 20, with Plates.

Evermann, Barton W., and Jenkins, Oliver P. Report upon a Collection of Fishes made at Guaymas, Mexico. Smithsonian Institution. Pp. 45, with Plates.

Fernow, B. E. What is Forestry? United States Department of Agriculture. Pp. 52.

Foster, Michael, and others. The Journal of Physiology. Vol. XIII, No. 3. Cambridge, England. Pp. 108, with Plates. $5 a volume.

Frazer, Dr. Persifor, Philadelphia. The Progress of Chemical Theory. Pp. 37.—The Warrior Coalfield of North Alabama. Pp. 16.

Funk & Wagnalls, New York. The New Standard Dictionary. Prospectus.

Ghisleri, Prof. A., Editor. Geographia per Tutti (Geography for all). Fortnightly. Vol. I, No. 1. Bergamo, Italy: Cattaneo Brothers. Pp. 16. 7 lire a year.

Gibbins, H. De B. The History of Commerce in Europe. Macmillan & Co. Pp. 283. 90 cents.

Hambleton, G. W. Physical Development. Pp. 4.

Harris, George H. Root-foods of the Seneca Indians. Rochester, N. Y.: Academy of Science. Pp. 12.

Heinzen, Carl. The Rights of Women and the Sexual Relations. Boston: Benjamin R. Tucker. Pp. 173.

Herrick, C. L., Editor. The Journal of Comparative Neurology. Quarterly. Cincinnati: Robert Clarke & Co. Pp. 100, with Plates. $3 a year.

Huxley, T. H. Les Sciences Naturelles et l'Éducation. Édition Française. Paris: J. B. Baillière et fils. Pp. 360. 3 fr. 50.

Ives, J. E. Echinoderms and Arthropods from Japan. Pp. 24, with Plates.

James, Joseph F. Paleontology of the Cincinnati Group. Pp. 28.

Keen, William W., Philadelphia. Laparotomy in Appendicitis. Pp. 9.—Linear Craniotomy in Microcephalus. Pp. 7.

King, A. F. A. Hysteria. New York: William Wood & Co. Pp. 22.

Kirtland, The C. B., Publishing Co., Salina, Kansas. The Agora. A Quarterly. Vol. I, No. 1. Pp. 60. 25 cents; $1 a year.

Lanin, E. B. Russian Traits and Terrors. Boston: B. R. Tucker. Pp. 288. 35 cents.

Lucas, Frederic A. On the Structure of the Tongue in Humming-birds. Smithsonian Institution. Pp. 8, with Plates.

McAdie, Alexander. Mean Temperatures and their Corrections in the United States. United States Signal-Office (War Department). Pp. 45.

McGee, W J. Account of the Progress of Geology for the Years 1887-'88. Pp. 42.—The Appomattox Formation in the Mississippi Embayment. Pp 6.—The Southern Extension of the Appomattox Formation. (Abstract, pp. 3; paper, pp. 17.)—The Field of Geology and its Promise for the Future. Pp. 16.—Encroachments by the Sea. Pp. 12.—The Flood-plains of Rivers. Pp. 12.

Marshall, Alfred. The Principles of Economics. Macmillan & Co. Pp. 770. $3.

Maynard, Charles J. Manual of North American Butterflies. Boston: De Wolfe, Fiske & Co. Pp. 226, with Hand-colored Plates.

Merrill, F. J. H. Post-Glacial History of the Hudson River Valley. Pp. 7.

Olmsted, Denison. Introduction to Natural Philosophy. Fourth revised edition. By Dr. Samuel Sheldon. New York: Charles Collins, and Baker & Taylor Co. Pp. 465. $2.50.

Pellegrini, Pietro. Dritto Sociale (Social Right). Mozzano, Italy. Pp. 360.

Peterman, Alexander L. Elements of Civil Government. American Book Company. Pp. 224. 60 cents.

Ridgway, Robert. Directions for collecting Birds. Smithsonian Institution. Pp. 26.

Ross, Irving C. The Neuroses from a Demographic Point of View. Pp. 14.

Russell, Israel C. An Expedition to Mount St. Elias, Alaska. Washington: National Geographic Society. Pp. 150, with Plates.

Sheldon, Samuel. Chapters on Electricity. New

York: Charles Collins, and the Baker & Taylor Co. Pp. 110. $1.

Shufeldt, R. W. Comparative Osteology of Arctic and Subarctic Water Birds. Pp. 16, with Plates. —Saurognathism of the Pici, etc. Pp. 10.

Spencer, Herbert. Justice. D. Appleton & Co. Pp. 291. $1.25.

Stejneger, Leonhard, and Test, F. E. New Genus and Species of Tailless Batrachian. Smithsonian Institution. Pp 2, with Plate.

Stewart, Seth T. Plane and Solid Geometry. American Book Company. Pp. 406. $1.12.

Weinberg, A. How to make a Trial-balance in less than an Hour. Baltimore. Pp. 23.

Whitman, C. O., and Allis, Edward Phelps, Jr., Editors. Journal of Morphology. June, 1891. Ginn & Co. Pp. 179, with Plates.

Wilson, H. Augustus. Illustrative Cases of Congenital Club-foot. Pp. 21, with Plates.

Winchell, N. H. and H. V. Map of the Iron Regions of Minnesota.

Winslow, I. O. Principles of Agriculture. American Book Company. Pp. 152.

Wisconsin, Report of the State Board of Health. Pp. 150.

Wright, John A., Philadelphia. Practical Working and Results of the Interstate Commerce Act. Pp. 40.

POPULAR MISCELLANY.

The American Microscopical Society.—The American Microscopical Society was the first of the scientific organizations to meet this year at Washington. Dr. John S. Billings made an address of welcome, and spoke at some length of the microscopic work that was done at Washington in the scientific offices of the Government, by the local society, in the Army Medical Museum, and particularly of that of the late Dr. J. J. Woodward. The use of the microscope in Government work was further discussed by Dr. J. Melvin Lamb. Most of the papers read were technical, but one by President Frank L. James, on the Microscope in the Investigation of Scorches and Burns on Textile Fabrics, relating how the instrument had been applied to establish the innocence of a man charged with murder, was of general interest. A committee was appointed to consider the feasibility of inducing American manufacturers to make their instruments of the same standard. A proposed new constitution was considered, and the society decided that it would call itself in future the American Microscopical Society instead of the American Society of Microscopists.

Value of Economic Entomology.—The study of insects was exalted in the address of Mr. James Fletcher as President of the Association of Economic Entomologists, who asserted that there is no branch of natural science or practical agriculture to which entomology is second in importance. The amounts lost and the value of the produce which might be saved every year in our staple crops alone by following the advice of the competent entomologist are so enormous, and of late years have been so often proved, that before long the value of these studies must certainly be more generally recognized. The chief hindrance is ignorance on the part of growers and consumers of agricultural products, which is being rapidly dissipated by the work of the agricultural experiment stations. Estimating the value of the agricultural crops of the country at about $380,000,000, an average of about ten per cent, or $38,000,000, was now lost—given up to insects without a struggle.

The Farmers' Crisis.—Nothing will be gained for us, either from an economic or political point of view, said Prof. E. J. James in his address before the Economic Section of the American Association, by belittling or deriding the views of Western farmers on the money question, on the tariff, or on railroad policy, taxation, and other topics. The American farmer has a grievance—a real and true grievance—one that will not become less by pooh-poohing it, but one that must be carefully studied by students of economics and statistics to ascertain, if possible, how far it is justified and whether it can be remedied, and, if so, by what means. As a matter of fact, the wealth of the United States is flowing away from its farms into its factories and railroads; from the country into the city; from the rural into the urban districts. The policy of our railroad companies has borne hard upon the individual farmer and upon the farmers as a class. It has altered all the conditions of agriculture in many sections of the country, and in nearly all of them in such a way as needlessly to burden and embarrass the farmer. Our system of taxation rests most heavily upon him; and there is no doubt that the financial policy of the country, including the whole system of monetary transactions built up by the combination of governmental and private initiatives, discrimi-

nates directly and keenly against the farmer and farming class, by discriminating in favor of other classes. Nor can it be said that the tariff policy of the country has been managed as much to the farmer's interest as to that of other classes. The way to improvement lies, in the first place, in the direction of altering these adverse influences. This policy, however, is merely palliative, and does not go to the root of the matter. The forces which are crowding the American farmer to the wall are world-wide. He is at a disadvantage because he is trying to compete with farmers of a low grade of civilization and intelligence in the production of crops in which intelligence and civilization count for comparatively little; and this competition is destined to become more formidable. The American farmer must seek new crops where intelligence and skill count for more than mere fertility of soil or juxtaposition to market, and where, having once established himself, he may bid defiance to the ignorance and inefficiency of foreign peasant, ryot, or boor. This calls for a broad and liberal policy toward agriculture in all its relations.

The Natural History of Analogy.—The subject of Prof. Jastrow's address in the Anthropological Section of the American Association was The Natural History of Analogy. Although this form of argument is used with great caution to-day, it was a predominant form among primitive people. Abundant instances of it were found in almost all savage customs and beliefs. In magical rites, in interpretations of omens and dreams, in medicinal practices, and social and tribal customs, striking instances of this kind of argument abounded. The Zulu who chews a bit of wood to soften the heart of the man he wants to buy an ox from, the fetich determining by whether a stick stands or falls whether a war shall be kept up or allowed to stop, the medicine-man who performs incantations over some personal belonging of his victim, or by the use of out-of-the-way drugs—were all instanced as the results of a feeling of analogy. Similar traits exist in children. An abundant field of illustration may be found in the popular superstitions, folk lore, and customs that have survived from a lower to a higher culture. The modern dream-book, household medicinal practices, charms, astrology, the doctrine of sympathies, furnish illustrations in point.

Derivation of the American University.—In his address on the Evolution of the University Prof. George E. Howard, of the University of Nebraska, traces the derivation of the American university through Oxford and Cambridge from the *studium generale* of Paris. The English college is regarded as "the direct prototype of the first American schools. The three most important foundations of the colonial period, which eventually became the models, directly or indirectly, of nearly all our higher institutions of learning, were in aim and organization reproductions of Cambridge or Oxford Colleges, with such modifications as new environments, religious ideas, and isolated position rendered necessary. Unfortunately, the principal defects of the English system were perpetuated. Thus the English universities were state institutions placed in subordination to a church establishment. Harvard, Yale, and William and Mary were in character practically the same. Each was chartered by the state—by the Colonial Assembly or the British Government—for religious purposes." Harvard escaped ecclesiastical trammels most easily, because in 1638, the theocracy being at its meridian, it was inconceivable that the clergy should not control the college, and they were not imposed so strictly as on the other institutions. American institutions also inherited from the mother-country a narrow conception of the sphere to be assigned to higher education—that scholastic spirit which has prevented our schools from entering into their proper relation to society. "Hence it is that the college professor, even yet, is too often the last man whom the people think of consulting on practical questions." Higher education is, however, undergoing a revolution which is briefly described as a tendency toward bringing the schools into closer relation with the social organism. This appears in several ways. The student, while devoting himself mainly to the duties of his academic life, remains a member of the social body. In our best institutions the relations of the student to his teacher are becoming such as

are favorable to the development of manliness and independence of judgment. While the classics and other branches of the old curriculum have been retained, and, subjected to the comparative method, are made vastly more productive than ever before for culture and general social good, a multitude of new subjects have been introduced. Instruction preparatory to nearly every new industry and profession is provided. Attention is given to questions that concern the state and the community at large. Administration, finance, constitutional history, constitutional law, comparative politics, railroad problems, corporations, forestry, veterinary science, charities, statistics, social problems—a crowd of topics, many of which a few years ago were unheard of in the schools—are now in many places subjected to methodical treatment. It is in the absolute necessity in the present crisis of the nation of providing the means of instruction in these branches that we find a strong argument in favor of the public support of higher education. The subjects mentioned, which enter into matters of daily and general interest, can be successfully treated only by specialists, and they must be trained in the schools.

The Colorado Cañon.—As described by Dr. D. Hart Merriam in one of the publications of the Department of Agriculture: "The Grand Cañon of the Colorado at the point visited is about fifteen miles wide at the top and six thousand feet deep. It is intersected by gulches and side-cañons of gigantic dimensions. It has ledges, terraces, and *mesas*, barren crags and grassy slopes, lofty mountains and deep valleys, cool hillsides clad in forests of balsam firs, and hot bottoms filled with subtropical thickets. It has arid stretches of sand bearing a scattered growth of cactus and yucca, and marshes and springs that never become dry and are hidden by the verdure of a multitude of plants requiring a moisture-laden atmosphere for their existence. Its animal life is as sharply varied and as strongly contrasted. In descending from the plateau level to the bottom of the cañon a succession of temperature zones is encountered equivalent to those stretching from the coniferous forests of northern Canada to the cactus plains of Mexico. These zones result from the combined effect of altitude and slope exposure, the effects of the latter being here manifested in an unusual degree. . . . The complex and interacting effects of radiation and refraction, of aridity and humidity, of marked differences of temperature at places of equal altitude on opposite sides of the cañon, of every possible angle of slope exposure, of exposure to and protection from wind and storms, produce a diversity of climatic conditions the effect of which on the vegetable and animal life in the cañon has been to bring into close proximity species characteristic of widely separated regions, and to crowd the several life zones into narrow parallel bands along the sides of the cañon —bands which expand and contract in conforming to the ever-changing surface."

The Sound of the Aurora.—"As to the aurora making an audible sound," says Mr. William Ogilvie in his The Upper Yukon and the Mackenzie, "although I often listened when there was a very brilliant display, and despite the profound stillness which is favorable to hearing the sound, if any sound occurs, I can not say that I ever even fancied that I heard anything. I have often met people who said they could hear a slight rustling sound whenever the aurora made a sudden rush. One man, a member of my party in 1882, was so positive of this that on the 18th of November, when there was an unusually brilliant and extensive display, I took him beyond all noise of the camp, blindfolded him, and told him to let me know when he heard anything, while I watched the play of the streamers. At nearly every brilliant rush of the auroral light he exclaimed, 'Don't you hear it?' All the time I was unconscious of any sensation of sound."

Agricultural Experiment in Wyoming.—In order that the possibilities of agriculture in all parts and altitudes of Wyoming may be fairly tested, the Trustees of the State Experiment Station have established experiment farms in various portions of the State. The west-central portion and the altitude of 5,500 feet above sea-level is represented by the Lander experiment farm of 137 acres under irrigation in Fremont County;

the Laramie plains and the altitude of 7,000 feet is represented by the Wyoming University experiment farm of 640 acres in Albany County, irrigated from the Pioneer Canal; the North Platte Valley and the altitude of 6,000 feet, by the Saratoga experiment farm of 40 acres, also under irrigation, in Carbon County; the northern part of the State and the altitude of 4,000 feet, by the Sheridan farm of 50 acres, under irrigation, in Sheridan County; northeastern Wyoming, with the greatest rainfall and the altitude of 4,500 feet, by the Sundanee farm of 49 acres, to be carried on without irrigation, in Crook County; and southeastern Wyoming, the Sybille Valley, and the altitude of 5,000 feet, by the Wheatland farm, under irrigation, in Laramie County. This distribution gives a good representation of the agricultural and grazing lands of the State; but other experiment farms will be established as the station funds permit. Researches are now in progress as to the capacity of gypsum to absorb and retain moisture. Special experiments have been instituted with varieties of grass and forage plants to be grown without irrigation.

Strychnine and Snake-bite.—The treatment of snake-bite with injections of strychnine illustrates the antagonistic action of poisons upon one another. Dr. Mueller, of Yackandandah, Victoria, in a case in his practice, used a solution of nitrate of strychnine in water with a little glycerin, hypodermically injected, with a frequency which was determined by the symptoms. When all symptoms had disappeared, the first independent action of the strychnine was shown by slight muscular spasms. The injections must be discontinued then, unless the snake-poison reasserts itself. In some cases a grain or more of strychnine was used within a few hours. The two poisons are thoroughly antagonistic, and no hesitation need be felt in pushing the use of the drug to quantities that would be fatal in the absence of snake-poison.

Irrigation in Egypt.—According to a note contributed to Nature by Sir Colin Moncrieff, the problem of perennial irrigation in Egypt has been satisfactorily solved, and that without the aid of the *corvée*, or forced labor. The subject of irrigation is treated under two broad subdivisions—the irrigation effected by the Nile flood, when there is rich, muddy water in abundance for a land three times as large as Egypt, and when every one considers it his absolute right to have his fields flooded without the expense or trouble of raising the water artificially; and the irrigation effected by the Nile at its lowest, in May and June, when it is only by the strictest economy that an area not exceeding one fourth of the whole of Egypt can be irrigated. It has now been made possible to raise the water in the river and divert it into the canals by the completion of a barrage or dam at the apex of the Delta. Such a dam was built several years ago, but soon after it was finished it cracked in an alarming way, and was not used. It cost originally about £2,000,000, and has now been put in a condition to fulfill the purpose for which it was intended, for the sum of about £460,000. This result is contrasted with the estimate of M. Linant, a former Government engineer, in 1872, that it would probably cost more to repair the existing barrage than to build a new one, and proposed pumping instead, at a cost of £465,000 per annum. Drainage for carrying off the superfluous water, which was not provided for in the French plans, is amply effected under the new system.

Bahama Fairy Tales.—The fairy tales of the negroes of the Bahamas, as described by Mr. Charles L. Edwards in a paper on that subject, are strongly localized, and built into a folk lore that is at once peculiar and interesting. The negro children are for the most part the medium of perpetuating them, but the conventional negro dialect is considerably modified by an intermixture of cockney and of correct English pronunciations. The same tale narrated by different persons, and by the same person at different times, will vary in the pronunciation of some of the words, and in unimportant details of the plot. The tales are divided by the narrators into "old stories" and "fairy stories," of which the former include the folk lore proper. The fairy stories have generally suffered modification in their transition into Bahama lore, and in some cases it is very difficult to detect the original. The "old

stories" have to do mainly with animals, while the characters in the fairy tales are generally human beings. The "Brer" of Uncle Remus, or the "Buh" of Charles C. Jones, is among the Bahama negroes contracted to B', which, connected with the name of the animal, personifies it. The habit of mixing together the parts of several tales in order to make one, as is seen in some of the fairy stories, gives us an odd and generally more or less obscure resultant tale. Prof. Crane, in his review of Uncle Remus (Popular Science Monthly, vol. xviii, p. 824), gives a number of parallel stories from the folk lore of other races, especially comparing the tales of the Southern negroes with those of the natives of South America, which illustrates the negro origin of the Indian tales, and points out their wide diffusion.

The First Ship that tacked.—The British sixteenth-century war-ship Great Harry, a supposed model of which was shown at the Naval Exhibition at Chelsea, possessed a great historical interest, because she was the first war-ship to sail on the wind. Naval architecture, says Nature, "as a science, was not founded until it was discovered that ships could be, otherwise than by the aid of oars, taken to the quarter from which the wind was blowing. It must have seemed a great feat in those days—little less than necromancy. Fortunately for the timid intellects of our ancestors, the revelation broke upon them gently, for the rounded hulls, high topsides, and curiously rigged craft could not have sailed more than a point or two to windward. Still, it was the Great Harry, or one of her contemporaries, by means of which this new feature in seamanship was inaugurated—a feature by which the middle period in the world's history of naval warfare was created, and which enabled the sailors of those times to make a distinct advance upon the lessons taught them by their ancestors in the art of shipcraft."

The Kibanga Calendar.—According to the Algerian missionary, Father Vyncke, the negroes of Kibanga, on the western shore of the Tanganyika Lake, although the sun passes twice a year perpendicularly over their heads, take no account of its march, and have no idea of the solar year. But the moon plays an important part in their lives. They celebrate its reappearance with drum-beatings, gunshots, and cries of joy. The new moon is celebrated with general dancing by most of the African tribes; and to keep the run of its age they have a bundle of twenty-eight or thirty sticks, from which they take one every day. The stars are consulted for the determination of the seasons, and to know when it is time for work in the fields, fishing, etc. The rising of the Pleiades marks seed-sowing time and is celebrated by feasts in honor of the dead, and the constellation is given a name, *Kiti*, significant of the fact. The milky way is designated by a name signifying the line between the dry and the rainy seasons, because when it rises at sunset the rainy season begins. The rising of Orion's belt determines the beginning of an important fishery. When another star, not named by Father Vyncke, reaches the zenith, the women begin to pound manioc. Aldebaran is the Northern, and Sirius the Southern Jewel. The Centaur, the Southern Cross, and the Ship, with the star Canopus, all invisible in the North, are called by the natives "paths" and "tens," because they are on the road to the south pole and are composed of many stars.

Ancient Mining on Lake Superior.—A paper by T. H. Lewis shows that the Lake Superior copper regions afford abundant evidences that an active mining industry was carried on there by the prehistoric aborigines. By inquiry among old miners, managers, explorers, and prospectors, the author ascertained that the ancient pits extended along the whole copper range from the extremity of Keeweenaw Point to and beyond the northwestern end of Gogebic Lake, a distance of fully one hundred and twenty miles. They are found also on the ranges to the north and to the south, as well as on the central range. Ancient pits are found, too, along the copper range in northern Wisconsin, and in the region northwest of Lake Superior, in Minnesota, and on the Canadian side of the international boundary line. The copper implements met with within the limits of Wisconsin, the author remarks, probably exceed in number those found in all the

other States combined. They seem to be most numerous in the effigy-mound region, and have been found in the effigies themselves. Outside of Wisconsin copper implements have been discovered in nearly all the other States east of the Rocky Mountains, but they have been most frequently found in Minnesota, Michigan, Ohio, Iowa, and Illinois. There are also effigy mounds in all these States, except possibly Michigan.

The Phonograph in Indian Folk Lore.—Dr. J. Walter Fewkes recently related to the American Folk-lore Society experiments which he had made with the phonograph in recording the songs, legends, and folk lore of the Passamaquoddy Indians. He claimed extraordinary accuracy for this method, in that it is rid of the liability of the translator to incorporate his own interpretations with those embodied in the stories recorded by him. Besides fragments of legends, stories, ancient songs, counting-out rhymes, and conversations got from the older men of the tribe at Calais, Maine, he obtained from the lips of Noel Josephs, who sang it when the ceremony was last performed, an old song—with archaic words and very ancient music—used in the "snake-dance." He also took records of war-songs, a curious "trade-song," and the song sung by the chief on the evening of the first day of the celebration of his election. These songs have been set to music from the records taken on the wax cylinders of the phonograph, and the words have been written out by the same means. Forty cylinders were filled with these records, some of which are stories yet unpublished. The results of the experiment are represented as showing that the phonograph is an important help to the study of Indian folk lore, both in preserving the tales and in the study of the composition of the music and the language.

Fresh-water Sponges in Florida.—Fresh-water sponges of the genus *Mexenia*, described by Edward Potts, were found in Florida on the stems of grass and roots of mangrove trees on the meadows near the head of a creek. The meadow is about twelve inches higher than the creek, and is subject to floods of fresh water during the rainy season, and occasional submergence in salt water. Notwithstanding the exposure to salt water and subsequent desiccation of weeks or possibly of months, the gemmules of these sponges preserved their vitality and germinated freely when placed in water. Differences were observed between the roughened gemmules of the sponges growing on the mangrove roots and the smooth ones of those growing on the grass stems. The specimens, in another package, of the same genus and of *Spongilla* were found adhering to the barnacles on the rocky bottom of a rapidly flowing creek; the barnacles having been brought up by the backing up of the salt water, and then become accustomed to live in fresh water. The *Spongillas* in certain features of detail resemble some lacustrine forms found on the Catskill Mountains and at sites in Pennsylvania and New Jersey.

Philosophy of Spectacle-frames.—The importance of a proper construction and adaptation of spectacle-frames is enforced by Dr. Charles Hermon Thomas in a paper on that subject. The results of the most accurate refractive measurements may be vitiated by a faulty position of the correcting glasses; and new sources of eye-strain may be created by the very means adopted to remove an existing fault. The optical center of a lens is generally that part of the glass which we wish to bring before the pupil, as that part of the lens and the area immediately surrounding it are freest from aberrations of all sorts—distort the least. Occasionally, however, it may be desirable to displace that point by a definite amount; in any case, we should insist on having the optician carry out our directions as regards the manner of mounting and the position of the glass with the same exactness that he employs in making it of the proper strength. The purpose of the spectacle-frame is to hold a pair of glasses before the eyes in a definite position and with the least possible annoyance to the wearer. The plans for the construction of spectacle-bridges devised by the author in 1878 provided for a wide range of adaptability to individual faces. The material of the frames should usually be gold of good quality, and of a weight as light as is consistent with strength and steadiness. Steel rusts too readily and is not well adapted to the adjustments fre-

quently required. The lenses should be as large as the face of the wearer permits, so that the eyes may be well covered in their ordinary lateral movements. The reflections from the edges of frameless glasses which annoy many may be avoided by slightly dulling the polish on the lower edge. The glasses should be worn as close to the eyes as possible without touching the lashes. Occasionally, when the lashes are especially long, with feathery or uneven ends, they should be neatly trimmed with the scissors, which is best practiced when the eyes are closed. It is also to be borne in mind that the subject has an artistic aspect, and that by giving proper consideration to this phase much may be done to remove the prejudice which frequently attaches to the wearing of glasses.

The Niagara Reservation.—The Commissioners of the State Reservation at Niagara, in their report for 1890, insist on the importance of making adequate provision for permanent improvements at Niagara, and especially of the restoration of the territory of the reservation to a state of natural simplicity and beauty. The work of restoration has for several years presented itself as that which should principally engage the attention of the board. Its applications to the Legislature for appropriations do not, however, seem to have been appreciated. But, in 1889, the grant of $15,000 for "repairs of roads, bridges, and betterments," enabled them to make a beginning, and they created a breakwater for the protection of the shore of Goat Island against erosion. Besides this $15,000 the appropriations for the maintenance and improvement of the reservation have in all not exceeded $75,000 since 1883; in return the commissioners have paid into the treasury, from the "earnings" of the reservation, $24,395, leaving $50,604 as what the reservation actually cost the State for maintenance during seven years. "To educated tourists, whether native or foreign," the commissioners say, "the disinclination of this great and prosperous State to provide means for the restoration of the scenery of the Falls of Niagara must appear somewhat surprising if not inexplicable. The fame of no other natural phenomenon in the world equals that of New York's great cataract." The popular approval of the State's acquisition of the falls has been exhibited so often and in so many ways that it can not be mistaken; and public condemnation, also often shown, of propositions to mar the falls for the sake of money-making schemes, has been significant, and gratifying to all who are interested in Niagara.

Firing Porcelain with Petroleum.—The porcelain manufacturers of Limoges, France, have been seeking for many years means of cheapening the cost of firing their wares, the expense for fuel there being two or three times greater than in England and Bohemia. Wages were reduced and new processes were tried without securing the object aimed at, till at last petroleum and residuum oils were tried, when results were gained far better than had been anticipated. The heat was found absolutely pure. No gases or smoke discolored the china, which came from the kiln whiter and in better condition than when it is fired by the heat of wood. In the muffles there was a decided advantage. The delicate colors, which show at once the presence of the slightest quantities of gas, were perfect. Consul Griffin thinks that this new discovery promises to revolutionize the whole porcelain industry. It is estimated that, by employing these oils, there will be a reduction of some fifteen or twenty per cent in the cost of making china.

NOTES.

THE New Jersey Weather Service, organized in December, 1887, has already accumulated many valuable meteorological data. It has, at the request of the Superintendent of the Eleventh Census, prepared and forwarded a table showing the mean annual temperature and the mean annual rainfall, determined from observations made at fifty-eight stations, together with the length of each series from which the mean was determined; it has furnished the State Board of Health complete annual reports of twelve stations; and has distributed weather indications, cold-wave and frost warnings, and, during the growing season, weather-crop bulletins. As established and now in operation, it is an organization of voluntary observers, co-operating with the United States Weather Service, the State Agricultural Society, and the State Experiment Station; the national serv-

ice detailing an experienced observer who acts as director and supervises the work carried on in an office furnished by the State Experiment Station.

In a paper on the Occurrence of Tin in Canned Goods, read in the American Chemical Society, Prof. H. A. Weber related a case of poisoning from eating pumpkin-pie made from canned pumpkin, in the investigation of which he had found as much as seven maximum or fifty or more minimum doses of tin salts in a pound of canned pumpkin. He had also found large traces of tin in canned fruits and tomatoes. The paper was very generally discussed, and it was agreed that the subject ought to be investigated. There is considerable difference of opinion among chemists concerning the extent and even the reality of danger from this source.

Prof. Springer informed the American Association that he has discovered a latent quality in aluminum which adapts it in a remarkable degree to use in the construction of sounding-boards. He has found that it differs from all other metals, so far as he is aware, in being free from the comparatively continuous and uniform higher partial tones that give the tone-color called metallic; and that it possesses an elasticity capable of sympathetic vibration uniform through a wide range of tone-pitch, that renders it in that respect superior to wood. The thickness of the sheet may be so reduced as to obtain the utmost amplitude of tone vibration without injury to the quality of the tone; and in this it is superior to both wood and other metals.

The photochronograph is an instrument intended to remove the personal equation in transit observations (astronomical) by means of photography. It was devised by Prof. Bigelow, of Woodstock College, and gave very satisfactory results as a first experiment with the star Alpha Aquilæ. The first apparatus was soon superseded by a second, and the second by a third, each being improved as the experiments suggested. An account of the instrument and its workings is given in a special publication of Georgetown College Observatory.

The Association of Agricultural Colleges and Experiment Stations adopted a resolution, at its recent meeting in Washington, asking the Secretary of Agriculture, in the interest of forest preservation, to secure the passage of laws exempting from sale or pre-emption Government forest lands now unsold, and to cause them to be surveyed, reported upon, and protected. It also suggested that the Weather Bureau organize and, co-operating with the agricultural colleges and stations, assist in maintaining a study of climatology in its relations to farming; and that the sphere of this work should be enlarged to include the physics, conditions, and changes of agricultural soils.

A cavern was discovered lately on the slope of the mountain at Baden which had evidently been used in the middle ages and long previously. Remains of the foundations of a vestibule were found at the entrance. In a niche hewn out of the rock was an altar with the sacrificial stone table. In front of the cavern was a regularly constructed building, fully ten feet below the surface of the ground above, designed probably to conceal the cavern behind, which may have been employed as a temple to Mithra. There were two stalls for horses, fragments of utensils, knives, flint arrow-heads, and carved bones, mixed up with Roman coins, lamps, and stamped tiles.

A course of lectures on the work of the Rothamstead Agricultural Station was delivered at Washington by Mr. R. Warrington, Vice-President of the Chemical Society of England, during the recent meeting of the Association of American Agricultural Colleges. At the conclusion of his lectures the speaker congratulated our country on having more than fifty experiment stations, each of them endowed with an income equal to or surpassing that possessed by Rothamstead; but advising his hearers that if at the end of fifty years each of our stations is to show a record of work done equal to or surpassing that accomplished by the old station in England, it will only be by each one pursuing its work in the same spirit of accuracy, thoroughness, and patience that has characterized the Rothamstead experiment.

The minor planets 296, 297, 298, 300, 302, and 303, have been named respectively Phaëtusa, Cecilia, Baptistina, Geraldina, Clarissa, and Josephina.

The address of Vice-President J. J. Stephenson before the Geological and Geographical Section of the American Association was on the relations of the Chemung and Catskill formations on the eastern side of the Appalachian basin. The speaker found that the deposits were not made in a closed sea, but that the influx of great rivers with their load of *débris* made conditions of the shallow basin such that life could not exist; and that in the present state of our knowledge we are not justified in including the Chemung period in the Carboniferous age.

The British consul at Hankow, China, writes that the varnish exported from that city is the gum of the *Rhus vernifera*, or varnish-bearing sumach. It has to be collected and strained in the dark, as light spoils the gum and causes it to cake with all the dirt in it. And it can not be strained in wet weather, because moisture causes it to solidify; but then it should only be used in wet weather, as, if the atmosphere is dry when it is rubbed on, it will always be sticky. As used by the Chinese, the varnish takes about a month to dry, and during the time it is drying it is poisonous to the eyes.

In his vice-presidential address at the American Association on the Evolution of Algebra, Prof. E. W. Hyde, in the Mathematical Section, made a concise presentation of the history of algebra from before the Christian era to the present time, and even projected the future of the science. After tracing it through the rhetorical stage of the ancients, in which the reasoning was done with words, and the syncopated stage of the middle ages and the revival of learning, when abbreviations were introduced and used instead of words, the author found it in the symbolical stage of the present, or that of arbitrary signs; and "finally, in the present century, we have noted the approach of multiple algebra from different and independent sources, whose value is the glorious future."

In a series of papers on The Unitary Science, the Science of the Future, Mr. Henry R. Rogers, of Dunkirk, N. Y., elucidates as the basis of the unitary philosophy the four cardinal principles of the unity or identity of all so-called forces; the conservation of force; the substantial character of force; and the identity of constitution of all celestial force.

The remains of about a hundred elephants have been found at Mont-Dall, in Brittany, where they are gathered on a surface of about nineteen hundred square metres. All the bones are broken, and it is thought that the animals must have been eaten by prehistoric men.

Two of the papers read at Washington before the Society for the Promotion of Agriculture are suggestive as to the nature of the agricultural character of soils. Prof. E. W. Hilgard held that maps showing simply the chemical constituents are of little value, and that a map truly to represent the agricultural quality of a soil should take into consideration geology, botany, climatic conditions, meteorology, and chemistry. Prof. Whitney, discussing the structure of soils and the circulation of soil moisture, showed that as much or more depends upon the physical condition of the soil as on the chemical composition. Where land is worn out, it is because a physical change has taken place, not because of any chemical exhaustion, for the chemicals are always there in abundance.

In the Biological Section of the American Association, Vice-President Coulter spoke of the future of systematic botany. Some one has said that the highest reach of the human mind is a natural system of classification. This simply means, he said, that when the results of all departments of botanical work are well in hand, then the systematists will be in a position to put on a sure foundation the structure they have always been planning. The real systematic botany, therefore, is to sum up and utilize the results of all other departments, and its work is well-nigh all in the future. It is bound to be the last expression of human thought with reference to plant-life, just as it was the first.

OBITUARY NOTES.

Dr. Eduard Schönfeld, Director of the Observatory and Professor of Astronomy at Bonn, died May 1st, in the sixty-third year of his age. His attention was especially directed to astronomy while a student in the University of Marburg. In 1852 he became a pupil and assistant of Argelander, who was beginning his *Durchmusterung*, or survey of the stars of the northern hemisphere. In 1859 he was appointed Director of the Observatory at Mannheim, where he prepared two catalogues of the variable stars. On Argelander's death, in 1875, he was made his successor at Bonn. He extended the *Durchmusterung* to stars in zones down to 23° of southern declination.

M. Alexandre Edmond Becquerel, an eminent French physicist, died in Paris, May 11th, in the seventy-second year of his age. He was the son of Antoine César Becquerel, the founder of electro-chemics, and himself led a career hardly less distinguished. The investigations with which his name is connected include those on the laws of electro-chemical decomposition, the disengagement of heat by electricity passing in circuits, the disengagement of electricity by mechanical action, the properties of electrified bodies, the action of magnetism on bodies, the property of diamagnetism, the magnetic quality of oxygen, the constitution of the solar spectrum, the chemical action of light, phosphorescence, etc.; respecting which he made important discoveries and published valuable papers in the scientific journals. He also published books — treatises on Terrestrial Physics and Magnetism (1847) and Electricity and Magnetism (2 vols., 1855), and a *Précis d'Histoire* of Electricity and Magnetism (1858).

Mr. Norman R. Pogson, for thirty years Director of the Observatory at Madras, India, has recently died there. Till 1851 he was connected with Mr. Bishop's Observatory in Regent's Park, where he took part in the observations for forming the ecliptic charts that were published there. He then became an assistant in the Radcliffe Observatory at Oxford, and there discovered several minor planets, and in his investigations of variable stars fixed upon the number whose logarithm is 0·4, which has been adopted to express the ratio of the amount of light that separates two consecutive magnitudes. He left England in 1861 to take charge of the Madras Observatory, from which several volumes of observations were published under his direction.

Captain Cecilio Pujazon, Director of the Marine Observatory at San Fernando, near Cadiz, Spain, died April 15th, in his fifty-seventh year.

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BOOK NOTES.

IN the course of the current month Messrs. D. Appleton & Co. will publish the new novel by Julien Gordon, entitled *A Puritan Pagan*. The interest felt in this book, which is regarded by competent critics as the author's strongest work, will justify a brief sketch of the writer, who has gained a brilliant reputation here and in England within hardly more than a year.

* * *

WHEN *A Diplomat's Diary* was published, last year, the book, curiously enough, was regarded as the work of a man. "Julien Gordon," said the *London Athenæum*, "is an author whose name is not known to the novel-reading public, and who yet writes with the readiness and confidence of a practiced hand. Mr. Julien Gordon, for a new-comer, deserves a welcome for his brilliant novelette, in which the elemental passions are set off against a background of the most artificial society imaginable." It was presently discovered that the new-comer in literature was Mrs. Van Rensselaer Cruger, and, as the *Book News* has expressed it, "literary fame has now been added to Mrs. Cruger's former reputation as a New York society leader at home and a frequenter of court circles in Europe."

* * *

IT is interesting to learn from the *Book News* that Mrs. Cruger's mother was the favorite niece of Washington Irving, who gave her away when she was married at Sunny Side. Her uncle, Charles Storrow, was a classmate of Lowell at Harvard, and graduated at the head of his class. In all the social functions of the metropolis, Mrs. Cruger takes a prominent part, but she nevertheless finds time for literary work of a quality which has attracted universal attention.

A PURITAN PAGAN is a story which has the merits of real warmth, feeling, and vitality. The author's characters live and move like men and women. They are not manikins, answering the jerking of a string. It is a story which has nothing in common with the literature of much of the so-called modern realism, which might as well be a portrayal of batrachian loves and hates. The book throbs with vitality, the dialogue is crisp and clear-cut, the interest is sustained, and the moral of the book is sound and impressive, for it is the moral that he who sins must pay the penalty. The appearance of *A Puritan Pagan* will be regarded as a literary event.

* * *

THE New York *Evening Post* has called Mrs. Annie Martin's *Home Life on an Ostrich Farm* "a perfect book of its kind." The praise is well deserved. This is a simple, healthy, graphic sketch of life in a strange country under novel conditions. It is written by a woman who is keenly observant and a lover of nature, possessed of a ready appreciation of the humorous and the picturesque and unusual, and able to describe everything which she sees in a singularly entertaining manner. Mrs. Martin's treatment of her curious surroundings on an ostrich farm in South Africa, is always sympathetic and good-humored, and the charm of these qualities is quickly felt by the reader.

* * *

MRS. MARTIN gives a full biography of the ostrich, from the time it is hatched, "with its sweet, innocent baby face, large eyes, plump, round little body, not unlike a hedgehog on two legs with a long neck," until its death. But the ostrich was not her only dumb

companion. As the *Evening Post* says: "The meerkat, or penciled ichneumon, the crow, the secretary-bird, Jacob—above all, the faithful collie, Toto—are described with infinite sympathy and humor, and are made to seem almost human in their intelligence. Some of them were evidently as fond of a joke as their mistress. When she went about the place, she was generally followed by a small train of animal friends. Among them was Bobby, the crow, who would come up noiselessly behind, and catching the tip of the merkat's tail in his bill, would lift the little fellow off his legs, take him up a few feet into the air, and drop him suddenly. Then, after waiting a few moments, until his victim had recovered his composure and was off his guard, he would repeat the performance."

* * *

THE book is accompanied by some admirable illustrations. The author's intimate and delightful treatment of her fresh subject will undoubtedly be appreciated by American readers, to whom the book will be presented shortly by D. Appleton & Co. As the London *Athenæum* says, "the work does not contain a dull page; it is a sparkling little book, of which it would be difficult to speak too highly."

* * *

THE experience of another woman who has faced the various mischances of farm-life with invariable good humor are set forth in Miss Kate Sanborn's delightful book entitled *Adopting an Abandoned Farm*. This book is published in Appletons' Summer Series, following Anstey's brilliant story of *Tourmalin's Time Cheques* and the novelette *From Shadow to Sunlight*, by the Marquis of Lorne. It is certain that Miss Sanborn's tribulations will be appreciated. She was beguiled by the offer of an abandoned farm, not many miles from Boston, at a ridiculously low price. She took the farm, and with it a Pandora's box, which presently opened of itself; but the evils which were released were none of them serious enough to overcome the author's good humor. It would not be fair to forestall the reader's pleasure by dwelling upon Miss Sanborn's experiences in gardening, in attending rural auctions and buying horses, and in experimenting with poultry. Ducks which refused to be coaxed into laying and finally turned out to be drakes, horses which had diseases or bolted at the slightest provocation, vegetables which refused to come up, and taxes which would not go down, are among the incidents of the life described with so much vivacity and cheerfulness, that the reader is left in doubt as to whether the adoption of an abandoned farm as an experiment is worth trying or not.

* * *

THE increase in summer travel within the last twenty years has made reliable guide-books an absolute necessity. The guide-books published by Messrs. D. Appleton & Co. are kept standing in type, and changes and revisions are made from year to year as they are called for. The new editions of the *General Guide to the United States and Canada* and of *Appletons' Summer Resorts* have well been called indispensable to travelers. The new *Canadian Guide-Book*, which has made its first appearance this summer, has been recognized as in certain ways a new departure in guide-book-making. The book is written by the well-known *littérateur* Charles G. D. Roberts, the Canadian poet, and the book is readable throughout. In addition to the ordinary and much extraordinary information, there are some charming sketches of canoeing and fishing trips, and there is a variety of information of the kind which every lover of outdoor life is anxious to have but can seldom find in convenient form. There is an appendix, with lists of Canadian trout and salmon

rivers and their lessees. Furthermore, the book is superbly illustrated, and the pictures represent the work of the best American artists and wood-engravers. There are not only large maps of the provinces of Eastern Canada and of Newfoundland, but there are also several small maps showing special sections.

* * *

IT is certainly within the bounds of modesty to say that no equally comprehensive and handsome guide-book to Eastern Canada has been published or contemplated. Messrs. D. Appleton & Co. have recognized the fact that Canada is becoming more and more of a sanitarium and pleasure-resort for American travelers, and it is believed that Americans will appreciate a book of the best class, furnishing descriptive, historical, and practical information which intelligent travelers desire.

* * *

THE influence upon court life exerted by the Prince of Wales, about which much comment has recently been made, is thus alluded to in the chapter devoted to Queen Victoria in *The Sovereigns and Courts of Europe* published by D. Appleton & Co. Speaking of the events following the death of Prince Albert, the author says: "That the effect of this withdrawal of the sovereign has been pernicious for England politically it would be false to maintain. Where the effect has been felt banefully is socially. It is true the Prince of Wales has taken his mother's place in this respect, but he can not replace the pure, high influence exerted by his father and mother. His aims, his sympathies are less exalted and intellectual than theirs; he loves pleasure for its own sake; he does not strive, as they did, to elevate the general tone of the nation. In consequence, the court has grown less pure, its tone more flippant; democratic and socialistic feelings have increased among the people; some of the old English integrity has been lost. It may, perhaps, be that these charges are the natural result of growth, of inevitable modification and mutation; but even so, the Queen's pure influence, had it been exercised, could but have acted for good in stemming the tide of a too-rapid transition from the old *régime* to the new, always pernicious and more than the ordinary mind can bear up against with safety. It has been held by some, and not without justice, that the court itself has but little direct connection with the life of the people, and, in one sense, this is true. During the fifty and odd years of the Queen's reign the court has altered little in this respect — that then, as now, it neither attracts nor attempts to attract the leaders in art, science, and literature. It is strange that royalty in England, at least — and we notice the same phenomenon elsewhere — seems only to have the power to attract round it second-class people. The best class of all, those who are continually advancing the country in science or keeping alight the flame of letters, who are its scholars, architects, engineers, artists, poets, authors, teachers, and preachers—as an English writer has well said, for these persons 'the court simply does not exist. The whole of those men who, in this generation, maintain the greatness of our country in the ways where alone greatness is desirable or memorable, the only men of this generation whose memories will live and adorn the Victorian era, are strangers to the court.' It seems a great mistake—for the court."

* * *

AMONG summer travelers there are always a large number who, if not students of geology as such, are well informed upon and deeply interested in geological facts, and who have the faculty of observation in travel. To not all such is it known that the geology of the regions traversed by all the principal railroad lines in the country has been care-

fully tabulated in the form of a railroad guide, so that the formations along the lines may be noted and compared with facility. The title of the work is *An American Geological Railway Guide.* It was compiled by Dr. James Macfarlane, with the aid of State and other geologists, and represents the work of some seventy-five specialists in this field. A second edition has recently been published. The introduction says: "... In these railway journeys no person can fail to notice the peculiarities in the scenery, and the great variety in the formations of rock to be seen in the railways cuts and cropping out on the hillsides. If we always had a professor of geology for our traveling companion, we would be glad to learn from him what these various formations of rock are, what place they occupy in the series of strata that are visible on the earth's surface, and their mineral and other productions; also at what other localities the same rocks occur, and whether they are entirely new to us or the same we have seen elsewhere. This work is a substitute for the supposed traveling professor of geology." The book includes untechnical descriptions of the formations in general.

* * *

SO much of importance in the field of geological research has lately been accomplished, even within a couple of years, that Dr. G. Frederick Wright has found it desirable to prepare a pamphlet of *Supplementary Notes* to the third edition of his *Ice Age in North America*, published in 1890 by D. Appleton & Co. The pamphlet is issued this month, and contains much interesting matter. As an example of the subjects actively discussed among geologists the following may be quoted: "The right of Mohegan rock, near New London, Connecticut, to be called the largest bowlder in New England is now challenged. Indeed, its right to be called a bowlder at all is disputed by Professor Crosby, who maintains that the rock is not only local, but that it has not been moved at all by ice. Dr. Wells, however, has reviewed the evidence, and is still of the opinion that, though the rock is local to that region, it, with several other similar bowlders, has been transported by ice to its present position. Professor Crosby would claim for a bowlder in Madison, N. H., the merit of being the largest in America. Its dimensions are 30 × 40 × 75 feet, which would give 90,000 cubic feet and an estimated weight of 8,000 tons. This is, indeed, less than Mohegan rock, according to the measurements I have given, but Professor Crosby would reduce the estimate of its dimensions, on account of irregularities in form, to less than 70,000 cubic feet, or 6,000 tons. But even the Madison bowlder must give place to one mentioned by Professor Edward Orton, who describes a mass of Clinton limestone near Freeport, Warren County, Ohio, as covering an area of three fourths of an acre, and as sixteen feet in thickness. It overlies glacial clays and gravels, and must have been transported bodily from the elevations containing this rock several miles to the northwest."

* * *

"TO the Old Boys of St. Paul's School" is dedicated a tastefully printed and bound volume of historical anecdotes entitled *Memorials of St. Paul's School, Concord, N. H.*, published last month by D. Appleton & Co. The book opens with an account, by Dr. George C. Shattuck, of the founding of the institution thirty-five years ago, followed by a most interesting outline of its subsequent history, concluding with the statement that nearly nineteen hundred names are now on its lists of alumni and scholars. The volume is illustrated, and includes a diagram of the grounds and buildings and vicinity, and can not fail to be appreciated by all friends of the school.

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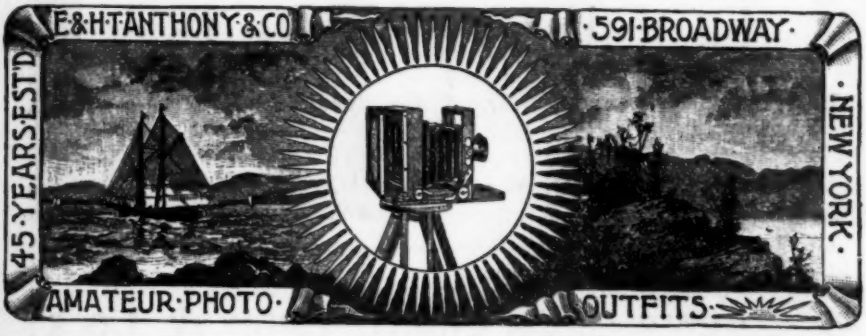

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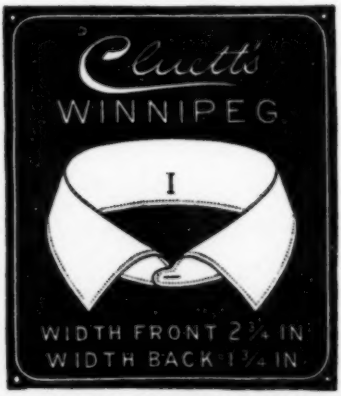

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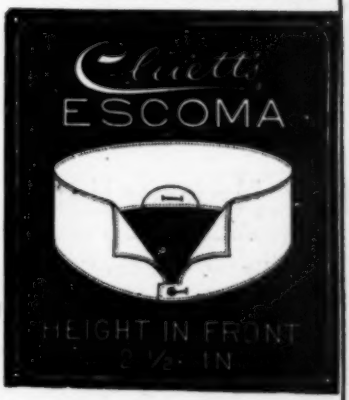

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AUGUST, 1891.

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JANUARY 1, 1891.

Amount of net assets, January 1, 1890		**$101,027,322 46**
Less Contingent Sinking Fund (reduced value in securities, Dec. 31)		568,525 11
		$100,458,797 35

REVENUE ACCOUNT.

Premiums	$28,863,654 71		
Less deferred premiums, January 1, 1890	1,635,643 37	$27,228,209 34	
Interest and rents, etc.	5,371 235 38		
Less interest accrued January 1, 1890	441,344 64	4,929,890 74	$32,158,100 08
			$132,616,897 43

DISBURSEMENT ACCOUNT.

Losses by death, and endowments matured and discounted (including reversionary additions to same)	$7,078,272 48	
Dividends (including mortuary dividends), annuities, and purchased insurances	6,201,271 54	
Total paid policy-holders	$13,279,544 02	
Taxes and reinsurances	290,257 97	
Commissions (including advanced and commuted commissions), brokerages, agency expenses, physicians' fees, etc	5,400,061 19	
Office and law expenses, rentals, salaries, advertising, printing, etc.	1,082,662 86	$20,052,526 04
		$112,564,371 39

ASSETS.

Cash on deposit, on hand, and in transit	$5,348,934 46	
United States bonds and other bonds, stocks and securities (market value, $67,250,984 74)	63,867,346 16	
Real estate	14,341,917 35	
Bonds and mortgages, first lien on real estate (buildings thereon insured for $15,000,000 and the policies assigned to the Company as additional collateral security)	19,446,083 13	
Temporary loans (market value of securities held as collateral, $5,391,511)	4,168,000 00	
*Loans on existing policies (the reserve on these policies, included in liabilities, amounts to over $2,000,000)	431,168 71	
*Quarterly and semi-annual premiums on existing policies, due subsequent to January 1, 1891	1,858,327 00	
*Premiums on existing policies in course of transmission and collection. (The reserve on these policies, included in liabilities, is estimated at $2,000,000)	1,431,828 15	
Agency balances	195,812 91	
Accrued interest on investments January 1, 1891	474,823 52	$112,564,371 39
Market value of securities over cost value on Company's books		3,383,438 58

*A detailed schedule of these items will accompany the usual annual report filed with the Insurance Department of the State of New York.

TOTAL ASSETS, January 1, 1891		**$115,947,809 97**
Appropriated as follows:		
Approved losses in course of payment	$813 040 54	
Reported losses awaiting proof, etc.	364,562 44	
Matured endowments, due and unpaid (claims not presented)	39,889 77	
Annuities due and unpaid (claims not presented)	22,901 83	
Reserved for reinsurance on existing policies (Actuaries' table 4 per cent interest)	99,954,304 00	
Reserved for premiums paid in advance	54,660 53	
		$101,049,359 11
Surplus, Company's Standard		**$14,898,450 86**
Consisting of		
Estimated contingent Tontine Surplus Fund	$8,670,539 50	
Estimated General Surplus	6,227,911 36	

From the undivided surplus, as above, the Board of Trustees have declared a reversionary dividend to participating policies in proportion to their contribution to surplus, available on settlement of next annual premium.

GROWTH OF THE COMPANY DURING THE PAST DECADE.

	New Insurance Issued.	*Insurance in Force.*	*Assets.*	*Annual Income.*
In the year 1880	$22,229,979	Jan. 1, 1881 $135,726,916	Jan. 1, 1881 $43,183,934	1880 $ 8,964,719
In the year 1885	68,521,452	Jan. 1, 1886 239,674,520	Jan. 1, 1886 66,864,321	1885 16 121,172
In the year 1890	159,576,065	Jan. 1, 1891 369,338,726	Jan. 1, 1891 115,947,810	1890 32,158,100

Number of policies issued during the year, 45,754. New insurance, $159,576,065.
Total number of policies in force January 1, 1891, 173,469. Amount at risk, $369,338,726.

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